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ABSTRACT

A set of articles with the theme "Mathematics for Real Life" is presented. These article titles are: (1) Teaching Mathematics as a Tool for Problem Solving; (2) New Math or New Education; (3) Hand Calculators and Math in Primary School; (4) Mass Media in the Mathematical Training of Polish Primary Teachers; (5) The Goals of Mathematics Teaching in Africa - A Need for Reexamination; (6) Mathematics Programmes - First Aid; and (7) Whither Secondary Mathematics - The Indian Experience. Also included are book reviews, several articles concerning trends and viewpoints, and articles concerned with general educational issues. (MK)

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Wincenty Okoń

All-round education and development of the personality

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All-round education

The concept of all-round education, as presented by a number of authors,[1] has now become fairly common currency in Poland. It refers to development of the individual under the influence of education—i.e. every type of teaching (not only at school) and learning—and, indirectly, the development of the younger generation, on which to a certain degree the development and progress of society depends. The idea of development denotes therefore above all the appearance of characteristics desirable from the social point of view, which are also desirable from the individual point of view. Development can, however, proceed in an undesirable direction, either as a result of uncontrolled or uncontrollable processes, or as a result of some consciously directed influence on human beings which is not in agreement with overall social and human interests, as well as with the welfare of the individual. Socially desirable development of human gifts, scientific interests or artistic talents is quite different from acquiring habits like smoking, drinking or taking drugs or disrespectful or dominating attitudes towards others, despite the fact that both kinds of development are the result of planned or involuntary influences of family, school, groups of schoolmates, individual persons or the media.

In both pedagogy and psychology we can distinguish two ways of defining the idea of human personality development. The first regards the process as primarily a succession of consecutive development phases, in each of which a certain combination of traits appears, paving the way for the appearance of a net set of traits in the following phases. This conception has now many supporters and is fairly firmly based on Piaget's psychology. In the other less popular meaning, we

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understand development as a process of directional changes in the student's personality, proceeding from simpler and less perfect conditions to more complicated and in some respects more perfect ones. As a synonym of development understood in this latter way, we use the term 'progress'. In our work, as can be seen, we differentiate between the concepts of development and progress, although it is obviously desirable that all pedagogical endeavours should have a progressive character.

Asked to what this concept of development refers we could give different answers, taking into account diversified criteria. The social sciences yield many such criteria. During recent years the systems of such criteria applied to pedagogical activity were given the name of taxonomies. The defect of these criteria and taxonomies consists in the fact that they treat the growing individual as a collection of certain characteristics, which are being manipulated pedagogically to bring them to relatively full development. In this respect the most significant—and at the same time the simplest (but not very often applied)—classification of characteristics differentiates between the instrumental characteristics and the directional characteristics. The first group refers to the recognition of reality by an individual and to his own influence on the reality, whereas the second is connected with the shaping of his relationship to the values and with the choosing of his aims in life. Other classifications differentiate more elements of personality and occasionally, as in the well-known taxonomy of B. Bloom, their number is colossal.

No satisfactory answer has been found so far to the question whether during the educational process it is possible to treat the growing individual and his personality as a complete being—as an indivisible unity. However, this kind of approach seems to be the only way of ensuring the harmonious and spiritually consistent development of the people concerned, reaching the deeper layers of their personality and influencing it in such a way—taking advantage of its own resources—that every pedagogical act should not only bear on the one chosen characteristic, disposition or aspect of personality, but at the same time assist the development of other characteristics, dispositions or aspects.

However, even if we want to treat personality as such as gradually and harmoniously developing unity (and such is the basis of the concept of all-round education), we cannot while influencing it avoid noticing some of its basic functions, which it always performs and to which it owes its existence and its development. Among those functions we count knowledge of the world and oneself, experience of the world and its values, and modification of the world. Those three typically human functions form at the same time the foundation of the concept of all-round education.

Knowledge of the world and oneself plays an important role in the contact of man with reality. Occasionally this role has been treated as the decisive hallmark of humanity. *Homo sapiens* still remains the biological definition of the human species. It retains its meaning even though it does not fully cover the essence of humanity. Man is also a being of valour[2] (*Homo valens*) who not only discovers the world but also experiences it as he develops his emotional life, which is integrally connected with the intellectual side of life. At the same time man is a being who changes the world which he inhabits. It would be impossible to consider him as *Homo faber* if he did not take advantage of the data obtained by perception and if he did not act in accordance with his aims, expressing his emotional relationship to values. Therefore complete man (*Homo concors*) is a harmoniously developed being, internally at peace, active in all three spheres: perception of the world, experience of the world, and modification of the world. He is at the same time a creative man (*Homo creator*) who—learning more and more deeply about reality, applying values to it and changing it—becomes simultaneously the author of new and original works and values in the realm of social and economic life, in the sphere of technical knowledge and in various branches of science and art.

Pedagogues and representatives of other social sciences have long been worried by the problem of how to bring people up so as to make them such harmoniously developed beings; how to overcome all the limitations connected with the existence of the class society, which by itself limits the all-round development of individuals; how to deal with the persistence of vestigial traces of the class society in classless societies; how to transform schools while teacher training is still imperfect; how to take advantage of the wide influence of social life as long as the general cultural and educational level of society is not very high; and how to speed up educational progress while inadequate resources are allocated to the education sector as a whole. These conditions, like many others, are responsible for the fact that in education one virtually always has to start from the beginning, usually attempting to graft splendid new ideals and pedagogical aims on to a still intractable reality.

The concept of all-round education is in itself a programme which aims at spreading *hic et nunc*, through schools and other educational institutions, a general level of culture which will help to develop educational practice along lines more conducive than the present methods to the creation of harmonious all-round personalities. This conception of culture is in full accord with the way in which culture is understood by Polish contemporary philosophers, foremost of whom is T. Kotarbiński. According to him:

> culture has the following characteristics: it grows from the history of a society as a result of work and co-operation made possible by understanding, and realized with the help of language; during this process, aimed at harmonization of coexistence through the blossoming of cognitive functions and their use in form of the technique, the precultural motivations give way to motivations created as follows: the impulses become more and more controlled, the immediate reactions are replaced by planned and long-term actions, aggressive emotions give way to emotions of a rather gentler nature.[3]

In this idea of culture, apart from its historical development and connections with language and development of social life, we find—as the dominating factors—three pillars of the concept of all-round education: the blossoming of cognitive functions, the development of motivation and the emotional life, and the use of science in the technical field. Let us now have a look at those three aspects, paying attention to those forms of activity, directed by the teachers and cultivated by the pupils, which may in the normal conditions already existing effectively influence the development of harmonious all-round personalities.

Perception of reality and assimilation of learning

The ability to learn is the most important of human abilities; for man owes to it the development of all his dispositions and of his whole personality. Learning is a kind of human activity, lasting throughout life, through the application of which man acquires new forms of behaviour and action, or changes previously acquired patterns. However, it is not the only category of human activity. A constant feature of other forms of human activity—such as play, work and different sorts of social activities—is inclusion of some elements of learning.

The simplest form of human learning is cognitive learning.[4] It comprises three varieties: learning from observation, sensory conditioning, and acquiring knowledge.

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Learning from observation consists in creation of lasting changes in perception of a given thing (or happening) on the basis of previous observation of the same, or a similar, thing. Those changes are based on the fact that by observing things we see them more and more clearly and precisely, reaching a degree of perfection such as that possessed by a botanist, who is able to differentiate between thousands of plants, or a wine-taster, who can tell several hundred types of wines.

The initial sensory conditioning is a type of cognitive learning which consists in the association by the student of two sensory stimuli: for example, association of an object and a sound. If we make the sound a conditional stimulus for some response, then demonstration of the object will cause a response, conditioned for sound. This means that the coincidence in time brings up an association of stimuli 'in the thoughts' of the given person.

Acquisition of knowledge—the third and most important kind of cognitive learning—is too much in favour in the modern school, and its mechanism requires a detailed knowledge of its working on the part of teachers. It depends on a situation stimulating part of the nervous system, thus causing changes in combinations, already existing within this system, which were created earlier. Under the influence of these changes the response to this or any other stimulating situation would be different from what it would have been before. Donald O. Hebb explains this potential change, as knowledge. Knowledge does not arise as a specific response to a specific stimulus, but as 'a modification of tendencies to react in any of innumerable stimulating situations'.[5] Due to knowledge, man is able to produce a diversified reaction to the same object, thus taking advantage of his previous experience. In addition, he acquires ability to produce many potential responses to different objects-stimuli, which may appear in the future. Possession of knowledge is not, however, identical with the ability to do something. When we acquire knowledge, we are usually contented with it, and we tend to forget about it shortly afterwards. Reinforcing knowledge prevents forgetting.[6]

The cognitive activity of a student is based on direct perception of reality and has a fundamental meaning. If we accept that the essential object of human cognition is not information about the world, but the world itself—i.e. nature, social life, culture and economy—this determines the source of cognition. It cannot be a textbook; it should be, above all, actual reality, i.e. specific objects, processes, happenings, and their connections and mutual interactions, learnt (if possible) in natural conditions and situations; rivers and mountains, plants and animals; people and products of their hands, the natural and social processes, institutions and social organizations, cultural resources—all that should fill and fertilize the imagination of students, should become the basis of knowledge of the world. On this basis can be built indirect knowledge, which has a general character and is therefore devoid of concrete meaning. This kind of knowledge is gained chiefly from printed sources, and at school from textbooks. As knowledge transmitted in such 'ready' form has an abstract character and usually does not appeal to the imagination of pupils, it is made more real—even partially—by the use of different teaching methods, which serve to bring the abstract closer to reality.

In this way, the perceptive activity of the pupils, based on acquisition of knowledge directly from the world around them, and on obtaining 'ready' knowledge, mainly from printed sources, can take various forms, which are turned to account by the teacher and by the pupils with a view to: (a) all-round utilization of the school environment as a source of stimuli; (b) selection of the more attractive sources of 'ready' knowledge; (c) utilization of ways of acquiring knowledge which assist in extending the period of remembering and retention; (d) use of effective methods of retaining knowledge by suitable repetition of information already gained and by its use in action; and (e) self-control and control of the mastering of knowledge.

This variety of teaching situations and stimuli, which leads to learning by assimilation, is appropriate to a school open to the environment and well endowed with special facilities for education and upbringing.

Exploratory activity at school

Study of reality can be conducted through direct 'peeping' at it, or through acquaintance with the 'ready' results of human cognition. This is, however, only a part of human cognition. It is true that in many schools this part is treated as the whole; but in a modern school an equally important part consists in independent study of the world by the student—through his own mental effort—in a process of solving problems and of becoming acquainted with the complexities of the world in this way.

This is especially necessary in the first eight to ten years of schooling, although the processes of solving problems can and should accompany man throughout his life. However, their importance for young people up to 15 years of age is connected with the opinion, widely accepted by psychologists, that at this age acquired intelligence (so-called intelligence B) reaches its highest point. In later years man can only enlarge the store of his experience on the basis of structures of intelligence created in the first fifteen years. We have to agree completely with J. Kaiser, who claims that 'during the period preceding the stabilization of intelligence B, in upbringing and teaching special stress must be laid on solving the problems and activization of verbal thinking, whereas mechanical learning by heart should be limited'.[7]

The basis of the real intellectual activity, with which we are here concerned, consists of the development of the mental abilities, and, in the first place, of imagination and thinking. The student will not develop these abilities solely by learning prepared information. He can, however, develop them by solving problems or, strictly speaking, by finding problems, formulating ideas, solving problems and checking whether his solutions are correct.

The concept of problem has been clarified in Polish teaching. In the subjective sense, it is a practical or theoretical difficulty, realized by the subject, which can be solved by him only by means of his own investigative activity. Objectively, a problem consists of a structure without complete data. The task of the person trying to solve the problem is to discover the missing data (unknown to him) and to complete the structure. Those data are simply some of the ingredients of the complete structure, or the relations and mutual dependence of the parts. Sometimes the difficulty lies in finding the missing elements or, when there are too many of them, in finding which are the right ones; sometimes it is necessary to discover a real relationship between some elements, or between the parts and the whole. Very often problems require the finding both of the elements and of the relationship between them. The degree of difficulty depends on the amount of data missing.

Processes of problem learning are completely different from processes of cognitive learning, which were discussed in the previous section. There, the ready answers were supplied by reality, and it was enough to perceive—more or less clearly—its fragments, or else by the 'ready' sources of knowledge, gathered by others. Here, the starting-point is the problem situation, which inspires the student to seek and to formulate the problem, to try to find ideas for its

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solution and to verify those ideas. The success of the individual within those three basic phases depends above all on his independent and creative attitude. Lack of such an attitude makes the individual unfit to take part in searching for a solution. However, this attitude is not given to anyone once and for all. It develops as a result of taking part in solving different problems, and its appearance at a given moment is due to the appearance of the problem situation.

The Soviet psychologist, A. M. Matiuszkin, describes a problem situation as a 'special kind of thought co-operation between the subject and the object'. It is characterized by a psychical state of the subject (student), during the work on his task, which requires finding (discovering or assimilating) the new information or methods of action, previously unknown to him.[8] To put it differently, the problem situation consists of a non-typical and in some respects difficult arrangement of the concrete or abstract elements and their relationship, while the student, finding himself in such a situation, possesses only partial knowledge about situations to a certain extent similar, at the same time not knowing how to complete the elements and relationships of the given arrangement, how to correct them, if necessary, or put them in order according to some rule, which must be found.

When such a problem situation appears during a lesson—either arranged by the teacher or spontaneously created by the pupils—then the pupils' first basic function is to notice and to formulate the problem (or problems). This activity obviously requires possession of knowledge and the ability to use it, as well as experience. In the first place, however, it requires an appeal to the imagination, and possession of the developed creative imagination which is necessary to counteract the already acquired cognitive blueprints, and to search for new ideas. This is a very important stage of the process of solving problems. An individual who himself formulates a problem will try to solve it with much more eagerness than if it is put before him by a teacher or if he has found it in a textbook.

The next stage consists of the creation of ideas (hypotheses) on how to solve the problem. This process, completely distinct from the process of verification of ideas, requires great flexibility of thinking, well-developed imagination and considerable ingenuity. It depends to a large extent on whether the situation is one of discovering something, or of creating something new and original. When we deal with problems during lessons in physics, biology, chemistry or geography, the problems usually relate to discovering some regularity in nature, some law of nature. In that case we apply convergent thinking. The lines of such thinking converge on the point where the law for which we are looking is to be found. The degree of freedom here is small; the student can only discover a given law (regularity, rule), therefore there is only one solution, which he must 'stumble' upon. Quite different is divergent thinking applicable to lessons in many subjects, especially the arts (literature, music, painting and sculpture), and technical subjects. Problems based on this type of thinking are 'free' to a great extent; the number of possible solutions is not limited. The number of ways in which you can write an essay is countless. The same applies to the methods of constructing some technical appliance, or of painting a picture.

The third stage of solving problems is connected with the verification of ideas regarding the proposed solutions. Verification can be both theoretical and practical. Here again there is a great difference between verification of solutions of the 'discovery' type, when you have to compare the discovered law with other laws and their practical application, and verification in the case of technical products or works of art, when you appraise them as technically or artistically more or less perfect achievements. It is significant that, for many years, schools paid no attention to problems of the 'creative' type and to the development of divergent thinking. This was probably due to the fact that in the past such qualities as ingenuity, flexibility, initiative, power of imagination or sensitivity to beauty were not sufficiently appreciated, although they are very desirable in everyone.

Experiencing values and emotional activity

So far we have regarded man as a thinking being, discovering the world—both more passively by learning through assimilation, and very actively through discovery. Both of these ways of learning are closely connected, and they enable pupils to master modern science and at the same time to develop their own cognitive qualities: thinking, the ability to observe, imagination, attention and memory. Providing the basis of intellectual early training, they make it possible to form scientific convictions and to lay the foundations of a scientific view of the world, as well as shaping such characteristics as honesty, initiative, ingenuity and truthfulness. It would seem that the foregoing qualities, far in excess of those which are usually promoted by many mediocre schools throughout the world, should be provided for in the curriculum of a modern school. However, this is not the case.

Education and intellectual training are the essential factors in building up the human personality and preparing the younger generation to be equal to the requirements of the era of the scientific and technical revolution, the era of colossal changes in the life of communities and of humankind. But are not those sudden changes and the feeling of insecurity that accompanies them caused by the destruction of the natural human environment, the appearance of new diseases, the diminution of reserves of raw materials, and colossal armaments, the result of a one-sided cult of reason in the whole world, accompanied by the progressive atrophy of higher human feelings?

This question, so important for the education of modern man, was answered not long ago by the distinguished Polish humanist, Antoni Kępiński, in his *Melancholia*:

> It seems to me, that the problem of the evolution of emotional life is, in times of crisis in our culture, a basic problem. The evolutionary jump which must be made by man to keep pace with the sudden change of the conditions of his life, caused by the scientific and technical revolution, must consist of change in his emotional attitudes and of development in the cultural level of his feelings.[9]

The claim of Kępiński, referring to a 'change in emotional attitudes'—those attitudes which consist in benefiting from the achievements of science without paying heed to the possible consequences—has a deep meaning in connection with the education of young people. In this respect much can be done by a complete change in the educational systems and in the mode of thought of teachers. The concept of all-round education serves the same purpose, because learning by experience will help to develop the emotional life of children and young people, which in turn will make it easier to perform this 'evolutionary jump', to which A. Kepiński refers.

Learning by 'living through' consists in creating, inside and outside the school, situations which give rise to emotional experiences in the pupils under the influence of properly displayed values, contained in a literary work, a play, film, picture, sculpture, piece of architecture, in music, in human action, or in beauty of nature, charm of the mountains, calm of the evening, or an atmosphere of waiting for something great to happen. Those values are either created by man, or offered to us by nature or by life itself. Every one of them has in itself something precious, which we owe to human genius, to the forces of nature or to the laws governing life. Anyone who can discover the precious element in those values and who is at the same time emotionally moved, will not remain indifferent to them. He will respect them, and will fight against everything which threatens them or is in contradiction with them. The experiencing of values constitutes both a basis for assessment, in which the scale of positive and negative valuation gradually expands, and a basis for valorous action.

Experience is then a sign of relationship of the subject to the moral, social, political, aesthetic and scientific values. This relationship is not understood by all in the same way. There are some authors who obviously separate the cognitive processes (as instrumental) from the processes of valuation (as directional). There are, however, those who claim that it is not possible to separate these processes. Among others, the Polish psychologist J. Reykowski clearly associates the processes of orientation with the processes of valuation. He writes that 'progress in the direction of pro-social attitudes is connected with the development of a network of perception'. He stresses at the same time that 'at least two important phenomena have to be accounted for: creation of the "structure I" (the necessary condition for reacting to the needs of similar people) and development of operative thinking (the necessary condition for functioning of the norm of justice)'.[10] In Polish pedagogical thinking a view is obtained, represented by Bogdan Nawroczynski, according to which the cognitive processes were integrated with the emotional ones and with processes of valuation.

As, for many years, I held similar views and did not wish to introduce a line of demarcation between education and upbringing, I often wondered why experience of different values leaves such permanent traces, not only in the 'network of perception' of man but also in his outlook on life and his attitudes towards various values. I came to the conclusion that in human experience, the source of which consists in values, there are both the intellectual-cognitive elements (because knowledge of the given values influences the strength of experience) and the affective-conative elements, which at the highest point of experience may be dominating. Thus in experience two sides of human nature are engaged: the cognitive processes give us intellectual reasons, whereas the affective processes give us full emotional satisfaction, although they can also create the feeling of displeasure and disapproval. In this way we have sufficient ground for defining our own attitude towards assessment of values, as well as incentives to action, arising from this assessment.

The results of learning through action, therefore, may have very great significance for the development of the pupil's personality. They comprise also cognition, especially subjective, connected with the pupil as a subject of cognition and with man in general, with his actions and creations, with the social structure and the whole of human culture. We should not disregard this cognition, because, due to emotional conditions, which accompany it, it penetrates deeply into our consciousness. However, an even more important matter is to awaken the pupil's feelings, especially feelings on a higher level, which enable the young man to overcome selfish attitudes for the sake of others, of his country and of progress in the world. Only through often practised forms of emotional activity can man gradually increase his emotional maturity in the same way that he increases his intellectual or physical maturity. A very important effect of learning through experience consists in acquiring skill in valuation, which cannot be acquired even by placing the greatest possible emphasis on the development of the cognitive processes.

Action and practical activity

The intellectual activity of man does not end with reaching into the sphere of emotional activity. It is impossible to imagine practical human activity without it, especially when proper use is made of theoretical science. An ability to see in theoretical knowledge the possibilities of adapting it to wide practical use, combined with an ability to utilize knowledge for the purpose of rational transformation of the existing situation, is of great importance in modern social life. Those aspects cannot therefore be disregarded in the modern school. Its task is frequently to put the pupils in situations where they can solve practical, technical, productive and social problems. Those problems enable them to learn more thoroughly the social meaning of the knowledge accumulated by mankind, while at the same time developing their own creative abilities.

Productive activity finds expression in the solution of practical problems and in every productive function. It consists in the transformation of reality, in the creation of something which has not previously existed. Here might be included tasks coming within the spheres of industry, agriculture, stock-breeding, the arts and everyday life. Many famous educationists, beginning with Fellenberg, Owen and Blonski, have pointed out the cognitive as well as the educational significance of this activity. It is impossible to imagine a modern school where there would be no place for numerous and diversified forms of such activity.

The Soviet educationists have for several years past conducted research on the methods of rationally combining the productive processes with their theoretical foundations. Their work has found expression in the development of the concept of the polytechnical education. In the light of this concept, learning through action acquires a new meaning, since activities of a practical and technical nature begin to be incorporated in the teaching in school of many basic subjects such as physics, chemistry, biology, geography, mathematics or technical drawing, not to mention the technical classes or the teaching of the foundations of production. At the same time, in accordance with the principle of combining theory with practice, the process of activity should enable young people not only to master technical operations in practice but also to understand the scientific foundations of the production of energy, engineering or technology.

The concept of learning through action obviously goes beyond the limits of polytechnical studies. However, in the teaching of all subjects the principle of combining the scientific theory with practical work is essential. I stressed in my *Proces Nauczania* that scientific information must form the basis of skills, learnt at school. This information has its place in the teaching of skills, in the shape of various standards, applied as principles or rules, to which the action is subjected. Viewed in this light, the ability to do things can be understood as the ability to apply various rules (standards, principles), while performing certain tasks.

As can be seen, learning through action may take various forms. The least educational is that learning which aims at acquiring physical skill alone, without connecting the task with a scientific basis. This kind of learning is represented by traditional forms of 'training'—usually vocational or military. The all-round educational value of such a method is very small, because it is confined to the acquisition of purely manual skills. Quite different, in respect both of education and of upbringing, are the values of activities, which apply theory combined with practice and practice combined with theory. The pupil—apart from learning the skills and usages (which cannot be secured by adaptation and perception, both being cognitive processes)—obtains from this method, with a great saving of time and effort, wider and consolidated knowledge, confirmation of its validity, and proof of its practical meaning.

The highest place must be given, however, to activity combining the guidance aspect with the information aspect, which appeals to the sense of independence of the student and at the same time obliges him to formulate and solve practical problems—namely, to technical creativity. An additional effect of this kind of learning is the development of technical thinking, technical imagination and ingenuity, initiation in rationalization and awakening of creative technical interests.

The common value of all forms of activity lies in their serious educational influence on human will and character, and at the same time on the formation of such aspects as the proper attitude to work, to social and private property, to work in itself and to working people. Without due attention to the development of those aspects, it is difficult to imagine a proper preparation of the younger generation for participation in social life.

Notes

1. Among others W. Okón, *Podstawy Wykształcenia Ególnego*, Warsaw, 1967, 3rd ed. 1976.
2. 'Valour' here is being used in the sense given to the word by T. Kotarbinski: 'A valorous man is therefore a man who is able to live honorably.' See T. Kotarbinski, *Medytacje o Zyciu Godziwym*, Warsaw, Wiedza Powszechna, 1966.
3. T. Kotarbinski, *Medytacje o życiu godziwym*, p. 35–6, Warsaw, Wiedza Powszechna, 1966.
4. Donald O. Hebb, *Podrecznik Psychologii*, p. 154 et seq., Warsaw, PWN, 1969.
5. ibid., p. 163.
6. A great deal of information about reinforcing may be found, *inter alia*, in my *Proces Nauczania*, Warsaw, PZWS, 1966.
7. Jan Kaiser, 'Zagadnienie Akceleracji Rozwoju Fizycznego, Intelektualnego i Spolecznego Dzieci i Mlodziezy', *Przeglad Pedagogiczny*, No. 4, 1974.
8. A. M. Matiuszkin, *Problemnyje Situacii w Obczeni*, p. 193, Moscow, Piedagogika, 1972.
9. A. Kepiński, *Melancholia*, p. 219, Warsaw, PZWL, 1974.
10. J. Reykowski, 'Rozwój sieci Poznawczej a Zachowanie Allocentryczne', *Studia Psychologiczne*, Vol. XV, 1976.

Kjell Eide

Education and communication in a future perspective*

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Reading the outcome of future studies may often bring to one's mind the story of the Australian aborigine who had got himself a new boomerang. But then his dilemma started; he proved unable to throw away the old one.

In futuristic terminology this simply means that we cannot change paradigms the way we change clothes. It takes a long time and hard struggle for an individual or a group to develop anything like consistent paradigms; when achieved they are likely to stay with us for the rest of our lives with only limited modifications. In principle, future studies should come to our rescue here. In practice, most future studies simply reflect our inability to discard our old paradigms.

In discussing certain aspects of possible future developments in education and communications, I shall make no claim to stand above such limitations to the human mind. But I am convinced that to the extent we are able to transcend such limitations to our thinking in those fields, we may make some important steps towards understanding the potential futures of our societies in general.

Interrelationships between education and communication

One connection between those two fields immediately comes to mind: education can be regarded as an important part of the total communication function in society. In education we try with the help of communication to change individual behaviour, and assumed behavioural changes provide an important rationale for the communication function in general.

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* Based on the opening lecture to a Nordic seminar on future studies under the auspices of the Nordic Ministerial Council, held in Rungstedgaard, Denmark, 18–20 April 1978.

Perhaps this is best seen by introducing the concept of 'learning'. If communication leads to behavioural changes, it must be because those taking part in the communication have learned something from each other. They have gained new knowledge, they have understood something better than before, or they have in some undefined way been exerted to an influence that changes their behaviour. But this is also exactly what we try to achieve in education. The school represents the institutionalization of important parts of communication in our societies.

Traditionally, the school took particular care of information directed towards the young. Today, however, this functional limitation is gradually breaking down. Education has also been more associated with direction towards specific aims than is the case with communication in general. The school has acted in accordance with specific behavioural changes thought as desirable in their pupils, and its form of communication has consequently been dominated by one of the actors, the teacher. But even in this case, old distinctions are being eroded. The school increasingly realizes that a good learning situation often presupposes mutuality in communication and less strict definitions of its aims. Genuine learning must be related to what has meaning for the pupil himself, it cannot only be based on behavioural change specifications desired by someone else.

It may be questionable whether the concept of learning covers all essential aspects of education and communication. Communication also means experience, even beyond what can be described as learning. We are entertained, we live for a moment at a dramatic level, and we feel warmth and solidarity. Perhaps we also learn something from this, but primarily it means that our lives become richer and more meaningful. The same is also true in school. Education is not only a question of what products emerge from the school system. We live an important part of our lives in school. We are not only preparing ourselves for something else, we experience ourselves in relation to others, and if there is a human right to happiness, that goes for schooltime too. We have to accept this as an essential part of the school's objectives, without necessarily arguing in terms of potential learning effects.

Staying a few moments longer at this rather superficial level, at which the school is seen as a part of the total communication function in society, a few comments may be appropriate on the balance between communication within the educational system and communication in general. As I see it, the school has experienced fundamental changes in its environment in the course of a few years. We have left a society in which knowledge and information were scarce goods, and where schools had a near monopoly on information to children and youth. We find ourselves in a society with information affluence and a complete breakdown of whatever information monopoly the school might have had. This inevitably has far-reaching consequences for the functioning of educational institutions. The authority position of the school as disseminator of knowledge has been undermined; even children have easy access to information which conflicts with what the school wants to convey. The school cannot any longer protect itself from contradictory information by pretending that the conflicts do not exist. Such information reaches the pupils in any case, creating the feeling that the traditional information provided by the school is less essential. Attempts to maintain the role of the school as the provider of officially authorized truth, may force the students to turn to other sources for relevant information and knowledge, obtained through forms of two-way communication which permits them to judge what they themselves find relevant.

Unavoidably this will change not only the relationship between the school and its environment, but also the internal power structure within the school. Competition within a society of information affluence will force the school to adapt to what students find meaningful. Instead of transferring authoritative truth, the school must primarily help the individual in choosing relevant information, on his or her own premises. Admittedly, school certification, closely connected to the selection for attractive social positions in society, can for some time force students to make efforts that are meaningful only in relation to examination results. But even the school's monopoly of certifying qualifications of importance to society is being eroded. Forms of certification quite independent of schools have been established in many countries. In the long run, the certification function cannot form the basis for the power position of the educational system towards its students. If such a position is to be maintained, it must be based on the ability of educational institutions to offer other services regarded as important by the students themselves.

The nature of communication

Speculations about the future must have a focal point, and in our case it is located at a deeper level than the one I have dealt with until now. Prolongation of historical trends can hardly serve such a purpose; a trend is not a force determining societal development. Only if we assume a stable balance between the real forces determining our future can trend prolongation contribute to our understanding of potential developments. Such a balance, however, can hardly be assumed today.

If we want to say something about the future of the essential aspects of our societies under discussion here, we must get beyond simple speculations about scope and direction in communication. We must examine the nature of existing communication, both within and outside the educational system. This concerns the relationship between the actors in the communication process, and points towards the power structure dominating communicating flows. Who defines what is relevant information in a given situation? Who decides what information is legitimate? Who structures information so as to correspond to specific conceptions of relevance and legitimacy?

Some interesting insights into such problems were offered by a recent Unesco conference, on information problems related to educational policy and planning. Interesting food for thought was provided by the head of the USSR Directorate for Scientific and Technical Information in Higher Education. At the top is a central bureau; there are fifteen regional offices, and under them information officers operate in each of the 700 faculties in Soviet universities. This information system decides in detail what information shall be available for every single researcher within those 700 faculties.

Rationalization experts in most countries develop detailed information systems to secure the 'relevant' information for each part of our administrative decision-making hierarchies, carefully ensuring that no 'unnecessary' information shall enter as 'noise' for the individual parts of the system. In this way, information that is 'legitimate' as a basis for decisions on each level and within each sector is defined. For some reason, we do not seem to have the same reservations in this case as when similar systems are applied to the feeding of information to research.

If we turn to the school we usually find the same detailed structuring of 'legitimate' information as a basis for teaching, with narrow limits for what the individual school or teacher can bring in on its own.

The reward structure within our systems have a tendency to discriminate against behaviour based on information not legitimized by the system.

Another relevant experience from the same Unesco seminar concerns the attitude taken by all the representatives of developing countries. In more or less polite ways they conveyed the following message to Unesco: Stop your attempts to develop more and more comprehensive and 'global' computer-based information systems. Only a handful of individuals in each of our countries can use them, and they are primarily used to reinforce the professional expert magic surrounding these individuals. It becomes an instrument in their fight to strengthen even further their power position in relation to the vast majority. If Unesco cannot contribute to the transfer of information that reaches most people, and which is based on their own conception of what is important to know, the organization's work in this field is not only wasted, but also potentially harmful.

This was definitely a hard line to take towards a United Nations organization, but it illustrates essential problems in the context of communication. It reflects a revolt by the traditionally passive receiver of information. They react against having imposed upon themselves information that is not only felt to be relevant, but still presented with the insistence that it *should* be regarded as relevant, and form the basis of important decisions. It was a plea (or a claim) for real communication instead of one-way information. It also illustrates how access to 'legitimate' information can be used, and is being used, to shape and reinforce national power structures, in a way that increases the distance between those who inform and those who become informed.

Who structures information?

In this context, I am not primarily concerned with developing countries; but in such countries problems often reach dramatic dimensions, which make it easier to realize that they are just enlarged versions of our own.

The knowledge we have systematically cumulated through centuries is strictly organized in sectors—disciplines—defending their territories with at least the same level of aggression as that of national States, and they have built up cultural and linguistic barriers as least as effective. They are all dominated by hierarchical structures, leaving no doubt about who are the high priests possessing the final truth. Long and strenuous carriers, filled with hurdles, are required in order to master the rituals that may provide access to high-priest status.

This is an international phenomenon, and again developing countries may demonstrate the effects most clearly. Researchers in those countries sooner or later have to face a clear-cut dilemma: Are they to emphasize recognition by the international research community in terms of its predominant criteria, or shall they use their insights in a search for solutions to the prime problems of their own countries? Quite often, there is no way of doing both, it has to be 'either or'. Most developing countries have a clear policy in this respect; they feel forced to create an élite that can form part of the international research community. Most individual researchers consequently do their utmost to become marketable in that community. The 'brain-drain' has been much discussed in terms of physical emigration of researchers from developing to industrialized countries. However, another form of the brain-drain has had much more catastrophic effects: the alienation in relation to one's own country and its problems among most of the researchers remaining in their native settings.

Knowledge is power, because it can be utilized. In our societies we also find that the status as expert is increasingly thought to legitimate positions of power, implying the right to make decisions with far-reaching consequences for others. Such expert power is built into our administrative systems, both in the public and the private sphere. It tends to refer the generalists to the bottom layer of the professional pecking order. This is true for practitioners in daily contact with real problems in the field, as well as for the politicians who at least in principle should represent the lay community.

Practical examples abound in most fields and in most countries. I shall only mention one, taken from the field of education, and from North America where it flourishes in its extreme form. In schools, even at the basic level, specialization has taken extreme forms. Everyone, except the pupils, are specialists, and preferably established in separate departments for each specialty. The pupils spend their time running between 'departments' for individual subjects, or for guidance, health, social problems, reading difficulties, writing difficulties, language laboratories, information centres, etc. If one cannot be a specialist on anything else, at least one can become a specialist on teaching the mother tongue in the fourth grade. No one has responsibility for more than a small slice of the child. Attending such a school, means to face every week perhaps twenty different adult specialists and a couple of hundred other pupils, without belonging anywhere. Even within such institutions, the suspicion may arise that perhaps someone ought to have contact with the whole child, and so the ingenious idea has arisen that the pupils' mothers might be invited in to keep some contact with the children and provide some warmth, of course free of charge or for some pocket money.

Such a system will, of course, through all its specialists, accumulate an enormous amount of data about the individual pupil, and such data are properly stored in computerized registers. They are necessary of course, since to be equipped with a proper range of specialists, schools of this kind are supposed to have an optimal size of 1,500 pupils. Somehow, however, this enormous amount of information does not seem to form the basis of real communication. The typical solution would of course have been to establish a separate department for specialists in communication with pupils, but one may be entitled to doubt if even this would solve the problem.

The example has features which may be found in most areas of organized activity in our societies. One could, for instance, refer to a major British study on hospitals ten years ago. Among many other phenomena, the frequency of questions from patients to the medical personnel was registered in each hospital. When comparing the third of the hospitals with the lowest question frequency with the third having the highest question frequency, the former proved to spend 50 per cent more time in curing patients with the same kind of disease. The difference reflects enormous sums in public expenditure.

Several reflections may emerge from such examples. One relates to modern organization theory, and especially a version named 'the garbage-can theory of organizations'. According to this theory, organizations have not only a series of problems searching for solutions. Within the organization, there are also a large number of solutions searching for appropriate problems. Slightly rewritten, it means that we have a series of specialists whose status and power position is based upon their carefully guarded monopoly on mastering certain techniques. But such techniques must be applied, and then reality is manipulated and adapted to fit the available techniques.

This is why one may feel excited when for instance the Norwegian Trade Union for the Metal Industries not only obtains the right to negotiate the introduction of new control, planning and information systems in the factories, but also has the right to have the system presented in a language the workers can understand. In order to prove the feasibility of the latter, the union undertook a 'translation' of some of the most frequently used control and planning systems into everyday language. It proved not only feasible, but revealed at the same time the banality of much of the inaccessible professional jargon in the field.

More generally, it is worth noting that the enormous potential for communication implied by computerized information handling, is applied in a way that usually leads to less communication between expert and client, or between those who govern and those who are governed. What fails is the possibility for clients to question, to judge the premises for available information, and for real choice between alternative information. This just underlines the obvious, that communication is not primarily a question of the amount of information located somewhere, but a question of whom it reaches and who governs it.

This category of problems also exerts itself at another level. Within all organizations is found a systematic structuring of information flowing vertically up or down between levels in the organizational hierarchy. Increasingly, this formalized flow of information is regarded as the only 'legitimate' premises for decisions. Previously, decision makers, for instance politicians, could also base their judgements on another, extensive but informal flow of information, communicated through organizations, mass media and informal contact networks. What we experience now, is that this external information flow is seen more and more as irrelevant, unprofessional and not legitimate. Only the internally structured information flow shall properly count as premises underlying decisions. This technocratization of communication implies a fundamental change in a power structure in most fields of our societies.

I should like to emphasize that even if my examples are mostly taken from openly bureaucratized organizations, corresponding phenomena exert themselves also in other sectors. We find them in productive enterprises, which in a decisive way determine our life conditions. We find them in the large organizations, which copy bureaucratic structures from business and major public systems. We find them in mass media, dominated by narrow, commercially decided criteria which also seem to penetrate public media. We find them in cultural life, where the informal prestige hierarchy can create as dominant high priests as those found in the academic world. Once again, the key question is not the degree of formal organization, but the nature of the communication that takes place.

Forms of learning

Let us go back for a moment to the concept of learning. According to a simple—perhaps oversimplified—learning theory, learning can have three main forms. We may have learning through imitation, when pupils copy the teacher because such imitation offers possibilities for rewards, or at least absence of punishment. We can have learning through identification, when pupils try to be like the teacher as a person and take over his value system as a basis for their own actions. And we have learning through internalization, when the pupils experience the teacher as an aid in their struggle to find solutions to their own problems, but when the 'answer' emerges from the pupils themselves. It is the latter form of learning we associate with the ideal of 'emancipatory' or 'liberating' teaching. On the other hand, indoctrination and manipulation is associated with the two former forms of learning.

If we generalize this to the whole field of communication, the key question becomes one of power relationships between the participants. There are striking similarities here between systems at various levels. In general development theory it is thought to be essential that developing countries fighting the same problems develop communication between themselves, instead of bilateral dependency upon dominating industrial countries. In organization theory, it is seen as essential to escape the one-sided emphasis on vertical communication between different levels within an organization, in favour of more horizontal communication between units at the same level, even if this violates the traditional principles of bureaucratic organization. In the school, research findings point to student interactions as perhaps the most important factor in a learning situation, probably more important than the teacher-pupil relationship. In medical institutions, there is also an emerging interest for active interaction between patients, at the expense of the one-sided specialist-patient communication.

But at the same time we experience that all the systems surrounding us are deeply entrenched in a tradition rewarding solely vertical communication, while horizontal communication is seen as a disturbance at best, and often strictly forbidden.

It is an interesting empirical question to what extent existing communication flows in our societies follow vertical or horizontal lines within the formal or informal hierarchies in the various fields. It would also be interesting to test the hypothesis that more and more of the limited communication resources available to the individual are occupied by vertical communication.

The connections with learning theory should be obvious enough. 'Emancipatory' communication presupposes a certain power balance between participating actors. If communication is seen as a form of exchange between individuals and groups, a meaningful exploitation theory could be developed for the field of communication, even if it means that one would have to break out of the framework of classical Marxist theory. I believe it possible to defend the proposition that in the Nordic countries, economic exploitation is relatively limited. On the other hand, it has major, and possibly increasing, dimensions in the field of communication. As in the case of economic exchange, exploitation is particularly strong when the strongest actor can force the weakest to accept his premises for judging values. In the old days, Africans soon learned that gold was expensive and glass pearls cheap. When the weakest partner has taken over the values of the stronger, one can always agree on reasonable exchange through communication.

Potential changes in power structures

The control over communication channels, their form and content, has always been a central means of power, and has been the focus of many dramatic conflicts in history. Information affluence does not necessarily change this fundamentally. As long as the communication capacity of the individual is limited, the power game is just oriented towards control over selection and structuring of information. This may, however, mean an essential difference in terms of who commands real power.

One can possibly outline some main alternatives for the future development of power structures in the fields we are dealing with. We can imagine a development towards a strict central programming of the kinds of systems under discussion. Probably we can do with some of the traditions of our own central school authorities, with some extra doses of educational technology, management by objectives and programme budgeting. It is still an open question where real power will reside in such central systems. It is far from certain that it will rest with central political authorities. It might as well end up with the tops of the expert hierarchy or the organization hierarchy. One could also envisage a continuing merger of the established top layers of different hierarchies, finding each other in common power interests.

We could also envisage a tendency towards decentralization to an institutional level, dominated by professional groups and sheltered against the institutional environment by centrally defined professional privileges. To what extent this would imply real decentralization, is again an open question. The real governance may easily reside with the professional or organizational high-priest level.

Another major future direction may imply much stronger control of systems and institutions by forces dominating the local community, which may imply much greater local variations in our societies. If through central policies we can compensate for inequalities in local resources, this might ensure more genuine equality in view of the varying premises dominating locally. But it should be borne in mind that for the individual, local tyranny may be far more difficult to live with than central governance at considerable distance.

Finally, we could imagine a much stronger element of 'user' or 'client' control, which would reduce the role of experts to more of a genuine service function. We would then probably be closer to the prerequisites for what I have called 'emancipatory' communication. But one should bear in mind that if the 'users' must organize the gain power, individual choice possibilities may suffer.

I shall not try to predict which of those directions will dominate future developments in our societies. We can perhaps assume that a certain element of pluralism may be maintained, and that none of the models for distribution of power indicated above will emerge in their pure form. But I am convinced that the power structure actually emerging in the future will more than anything else determine the general nature of future societies.

It is a question of basic political choices, and those choices will only to a limited extent be determined by technological conditions. The widespread assumption that in the last instance, technological development is the decisive factor, just reflects our failure in examining and drawing the necessary conclusions from existing choice possibilities. This seems to me to be the prime challenge to further research activities and political thinking in those areas.

Viewpoints and controversies

Reflections on the teaching of geography

Jean Dresch

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Geography appears to be a rather ill-defined field of study, not only to children in primary or secondary education, but also to students in higher education and the general public. Geographers themselves would not disagree. Is it a natural science? Physical geography does in fact encompass the study of land relief (geomorphology), climate (climatology), continental or marine water resources (hydrology), soils, vegetation and fauna (biogeography), although these sciences may be open to researchers who are not geographers. Is geography a human, social or economic science? It does indeed involve the study of population, rural areas and agriculture, cities and industry, service industries, transport and trade, etc., although other social sciences may well also lay claim to these fields. Could it then be said that geography has no specific object of its own? What is the connection between physical geography, a natural science, and human geography, a social science?

These are the determining factors in debates and crises over concepts and methods between teachers and students in universities and among researchers. These factors also give rise to some bewilderment within the general public trained in primary and secondary education as well as among schoolchildren themselves, their teachers and education authorities who do not quite know what to do with geography in primary and secondary education. In some countries, geography is not taught at all, or it is not taught beyond primary education, or it is an optional subject. Sometimes it is associated with other subjects and taught by a teacher who has not been trained specifically in geography, or it is linked preferably with one other subject, such as history, for example, as in France, or with social sciences. Or else it is divided up into sections, physical geography, on the one hand, being merged with the natural sciences and human geography, on the other, with the so-called human sciences. The same is true in higher education. Sometimes, geography is taught in faculties of 'philosophy' and physical geography left aside; elsewhere faculties or institutes of geography focus their studies either on physical geography, as in the USSR, for example, or conversely on human geography, unless they are actually taught in different institutions.

Curricula in primary and secondary education reveal the same uncertainty. In some countries, the teaching of geography involves filling the children's brains, according to their particular age group, with facts about land relief, climate, rivers, vegetation, population, agriculture, industry, towns and trade: an accumulation of names and figures. At the end of his studies, the pupil is supposed to know what is appropriate about the world in which he lives, in its entirety. The study of geography is an exercise in memorizing. Through wanting to cover the whole world, geography is turned into an encyclopedia; the student gets bored, learns nothing or simply forgets. This was often, and still is, the case in France, where the average Frenchman has the reputation of not knowing anything about geography, that is, of being unable to situate any particular country or town. To avoid this encyclopedic type of teaching, it was decided in many countries to integrate geography with the social sciences and history, at least in the upper forms, where teachers sought to introduce students to the 'environment', more human than physical in its complexity.

In other words, geography, in almost all countries, seems to be searching for its identity—in primary and secondary education, to begin with, and subsequently among the public at large, whose knowledge of geography amounts to little more than childhood memories. As it is at one and the same time a natural science, through its physical aspects, and a social science, through its human aspects, geography seems to have difficulty in fitting in, not only as regards the academic classification of sciences, but also in terms of the thought patterns to which everyone is accustomed. It is generally thought that a real subject, worthy of the name, could not have such a varied and diverging range of scientific focuses, unless it is forced to borrow its facts, concepts and methods from other sciences on which it comes to depend, to be little more than a classification catalogue, somewhat removed from practical experience and everyday life. It would then be of little use.

This, in fact, is how geography appeared during the nineteenth century in the school curricula of what have come to be known as the developed countries. The middle classes were investing in industry, setting up their banking system and prospecting for resources and markets, not only within the national borders but throughout all the recently discovered continents, establishing their domination, directly or indirectly, over colonial empires and sharing out the world. Just as geographical societies organized expeditions to hitherto unknown countries and published their findings, so it seemed right that young children should be taught about national power and the progress of expansion overseas, and even the international rivalry to which it gave rise. But it was no more than a tribute to the glory of the explorers, the conquerors, the businessmen, the missionaries who were bringing 'civilization' to countries that were said to be barbarous and primitive, to regions where virgin forests, the savannah haunted by fearsome animals, the limitless deserts and even the icy tracts of the arctic regions fired the imagination of the general public and the schoolchildren with heroic imagery. Geography in those times was part of the general education of the young middle-class man who was getting ready to join in the adventure. It gave him knowledge which would enable him to place the events related in the press. It did not provide him with any training which he could subsequently use to acquire a profession, except that of a teacher.

Even after the First World War, this descriptive, analytical approach to geography, with its passive acceptance of information supplied largely by other disciplines and official ideology, continued to prevail in most countries, all the more because geography in the USSR was mainly focused on the study of the natural environment, in accordance with an old tradition of Russian geography. By the emphasis laid in school on the connection between natural phenomena and methods of land occupation, production and economic and social organization, children were led into a determinist approach prejudicial to tropical countries (too hot, too wet or too dry, harsh and unhealthy), and in respect of the cold countries, to a passive attitude of pessimism, which accounted for the superiority of the earth's temperate regions and justified the colonial system, imperialism and white supremacy. This kind of justification could lead, all too obviously, to racism and even to fascism. So the conception of geography adopted in teaching was essentially static. Pupils were taught solid information, which set out to define particular types of land relief linked with recognized geological formations, with the dynamics peculiar to each bioclimatic region cautiously based on averages, and to specify the originality of geographical regions, chiefly seen as natural regions to which men had managed to adapt themselves in accordance with their civilizations and the technical means at their disposal. Notions of landscape, regions, organization of space could vary, admittedly, from one country or university to another and be the subject of debates between opposing schools of thought at international congresses; in primary and secondary education, however, geography was a description of the world without controversy or anguish. Little thought was spared, as yet, for natural resources which were shared out and traded under conditions which gave complete satisfaction to the industrialized countries. Nor was there anxiety about population growth in the colonized countries. The infant mortality rate was beginning to drop, the major calamities, epidemics, endemic diseases and famines, etc., being checked more and more. What better evidence could there have been of the blessings of Western society?

It was only after the fascist crisis and the Second World War, after the accession of the colonies to political independence, the expansion of consumer economics and the speeding up of technical progress, at least in the developed countries, with the growing contrast between these and the countries usually classified as part of the Third World, only towards the turn of the twentieth century that concern began to grow. How can such concern have a bearing on education? Geography would seem to be the school subject most likely to open up children's minds and their curiosity to the present-day world and the problems of tomorrow. It is to be assumed, moreover, that the developed child is much more integrated into the life of the community, whether national or international, than were his parents or his grandparents. The mass media reach him, cinema and television multiply the various pictures he can have of the world, holidays, children's magazines and even sports provide further representations of it. Admittedly, only a minority of the children of the world are concerned here and, even in the developed countries, it would be foolish to imagine that awareness of the world is the same for all. Geography could make up for this, to the extent, of course, that children attend school.

This is or should in fact be its role. Thus, in many developed countries and subsequently in Third World countries (in so far as textbooks from developed countries are still used or at least copied) textbooks attempt, through the use of pictures, photographs and maps, to illustrate the diversity of landscapes in the world. Pictures often end up playing a more important part than the written word. . . . It can be hoped, at least, that events over the last few decades have contributed to breaking down the barriers between the various disciplines which accounted for the inconsistencies in the teaching of geography before the war. The distinction between the exact or natural sciences and the human sciences has become increasingly academic as mathematics—with its statistical and quantitative methods—and data processing have come to be used in all the sciences. If, in the past, geography could not be classified among the sciences because it was at once physical and human, it has recently been recognized that the distinction between physical and human sciences, so strictly upheld in schools, universities and research institutions alike, is increasingly unjustifiable in its traditional rigidity.

Our good earth, its atmosphere, its lithosphere, its biosphere and hydrosphere, its natural resources are not materials that man can exploit indefinitely. Ever since the age, which is comparatively recent in human history, some 10,000 years ago, when man began to work the land and to breed animals in various parts of the globe, he gradually came to occupy and transform a sizeable part of the surface area of the continents. Not all of the surface area, and the transformation he wrought varied in extent according to the methods used. It is with the study of this occupation and this transformation of space, that is to say natural space and inhabited, transformed space, that geography is concerned: the extraordinary adventure, unique in the solar system, of the earth changing over more than 3,500 million years, and man, for some 3 million years, living on it for a brief instant, on the scale of geological ages. Man has gradually extended his domination over the world by practising methods of production, setting up links between his own patterns of social organization and the natural resources, and by superimposing on natural landscapes those of a surprisingly varied human kind.

In the last few decades, he has perfected techniques of such power that the human 'adventures' in various parts of the world have become uniform, the delicate balance, always unstable, between natural conditions and methods of production has been destroyed or is likely to be, and that human communities, together with the whole of the living world, are threatened with catastrophe.

The schoolboy of bygone days could make do with descriptive geography, limited to natural resources and the diversity of landscapes bearing the human imprint. It filled his mind. Most young people were destined to lead their lives in a fairly confined part of the world, other regions remaining very remote before the aeroplane and the development of modern means of communication. They could hardly feel concerned by events occurring on the other side of the world, the peasant colonized by something taking place far from the familiar confines of his village. Indeed, that he should be interested or not in geography had little effect on his future, unlike the acquisition of his mother tongue—or even foreign languages—mathematics, physics or chemistry. Today, we can no longer accept a type of education that fails to open up the mind of the student not only to the problems of his own regional or national community, but also to international problems that may have decisive influence on his future: international relations, both political and economic, the conservation, exploitation and distribution of natural resources, markets and consumption, etc. He must be made to realize that his own future goes hand in hand with those of other pupils in schools throughout the world.

Geography should therefore provide information and stimulate thought on the links between natural sciences and human sciences, such as ethno-sociology, economics and history. According to their age and the level of their studies, schoolchildren can learn from geography why there are mountainous and flat countries; countries which are hot or cold, humid or arid, where men arrange their lives differently; soils that human intervention can transform as well as crops and animals, biocenoses and ecosystems distributed in space so meticulously that it would be risky to meddle with them; why continents and oceans contain resources in limited quantities, especially those that cannot be renewed; how man uses these according to the methods he has at his disposal, thereby modifying nature or the environment; by what methods and for what economic and social reasons he often wastes and destroys them, polluting the earth's precious atmosphere, its continental and marine waters, no less indispensable to the existence of all living creatures; what links there are between the human population which doubles every thirty-five years—in varying proportions according to different regions and particularly whether they are rich or poor—and the exploitation and management of its resources; what tensions between regions, States or continents stem from the inequalities in the occupation of such varied space, the ownership or control of resources, the daily calorie intake, the gross domestic product and its distribution among the inhabitants of a State, the prices of produce traded, living conditions which send rural folk towards the towns and workers from the poor countries to seek employment and hope in countries remote from their own, let alone the arms trade and the upheavals of terror.

For it is not a matter of mere intellectual curiosity. It involves the destiny of each and every one of us. The teaching of geography cannot leave the student indifferent, unmoved or uncommitted. If it succeeds, depending on age, in bringing understanding, it should (as evidence of its success) arouse sympathy for animals, plants and natural landscapes, respect for all that is alive, the desire not to contribute in any way to destroying or spoiling these extraordinary terrestrial ecosystems of which man is so intimately a part. It should also awaken fellow-feeling for man, whatever his class, colour and culture; a young school-leaver should not be racist, and to condemn such and such a socio-economic or political system should not move him to hatred or violence. Geography, in conjunction with other subjects taught, yet in a privileged position on account of its subject-matter, should contribute to shaping the moral character of the schoolchild.

A difficult subject to teach. Now that public awareness of the dramatic relationship between nature and human action is beginning to dawn, the child at school must perforce have a grasp of reliefs and climates, rivers and oceans, soils and vegetation, all the heritage which man must care for, and also come to know the populations of the world, their methods of production, their agriculture and industry, countryside and cities, trade, etc. And there we are back with an encyclopedic, hold-all geography, a memory exercise. In France, for instance, why not learn the code numbers to the departments, just as we used to learn the names of the departments with their prefectures and sub-prefectures? It is useful, but it is not geography. Audio-visual methods and the mass media have completely modified the conditions in which the child gets to know the world, without teaching methods being correspondingly altered. School textbooks have been enriched with pictures, photographs, maps and charts, often in colour, at the expense of the written word. It is certainly useful that the child at school should have maps or an atlas so as to situate the data, names and figures that he hears about. Photographs are never adequate to illustrate the original features and diversity of landscapes, to make them comprehensible and encourage a spirit of inquiry. The child of today, however, living in developed countries, particularly in towns, lives in a world of pictures, presented by television, films, newspapers and magazines, comic strips, posters and brochures. Unfortunately, the geography teacher hardly ever appears on television, or anywhere else, for that matter. The eminent geography teacher, today, is the special correspondent, the reporter whose job is to photograph, interview and explain anything on the surface of the earth whenever a sensational event occurs, earthquake, flood, war, presidential or ministerial visit, but also surveys, expeditions to remote countries, etc. Whether this permanent vision of the world is produced along the lines of thorough geographical methods is open to doubt and regret. Hence it is to be hoped that the geography teacher will have at his disposal a selection of maps, slides, films, photographs and books which will enable him to arouse curiosity, intelligence and sympathy. And of course, that he has himself received the necessary training.

At least it is possible to imagine geography teaching not only technically improved, in schools with adequate means, but outside the school, associated with television and cinema programmes, newspapers, magazines and books. The school is, like the university, a closed environment where, to train the child's mind in peace, he is shut up within four walls for several hours each day. Undoubtedly a teacher, with proper material at his disposal, can accustom and train the child to examine and explain a map, a picture, all sorts of documents, which are artificial reflections of life. Nature and human activity are not, first and foremost, abstract concepts, and the conceptualization of either, as well as the relationships between them, the analysis of systems, ecosystems, economic, social or political systems, can only be undertaken in the upper forms at school, and will only be of value if the pupil has already developed a capacity for observation, if he feels the need to break out of the passive approach acquired through the routine of the daily school timetable, to look, observe, inquire and to ask himself questions about the spectacle of life. Geography should be learnt, at least in part, outside the school walls, in the living world, the countryside, its land, plants, animals and rural people, or in the city, with its buildings, streets, workshop and market-place. Books alone cannot teach understanding and sympathy; these can only be really acquired through contact with other people.

This conception of geography teaching may well be considered somewhat unrealistic. The teacher has a difficult task on his hands, whatever the means put at his disposal; the parents' task, too, is far from negligible, since it extends the teacher's efforts without the child taking undue notice. But if man, over the next 100 years, goes on squandering the natural resources he believes are at his disposal to the point of being unable to satisfy his own increasing needs, if the gap between rich and poor, between empty bellies and full ones, continues widening to the point of multiplying tensions and conflicts, how can the child at school be made aware of it merely by learning off chapters in his textbooks, as long as the rich never come to know the poor and the poor are left without any specific hope of a better life?

Slogans and the educator

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'Slogan' is a pejorative word; nobody, no party would ever think of saying 'my/our slogan'. The word, in fact, belongs to the world of advertising and political propaganda. It therefore seems incongruous to speak of slogans with regard to educational theory, that is, all the ideas that educators express about their own profession. Such phrases as: 'There is only one thing I am sorry about—that I did not get to know the school of life earlier' or 'Knowledge is riches' are indeed slogans, but they have no educational connotations; they are nothing but 'salesmen's patter'.

True slogans, however, those that have the greatest effect and constitute the greatest danger, are not necessarily the most striking, by any means; true slogans are those that succeed best in concealing their real nature. Besides, the language of education is not merely descriptive, but thought provoking and polemical; everyone who has an educational theory tries to gain acceptance for it by contrasting it with others; on a deeper level, education is the battle-ground of a power conflict, not merely an educational conflict, but a political conflict in the broadest sense of the word. It is, therefore, hardly surprising that slogans should be bandied about in this field—more of them, perhaps, than in many other fields.

Slogans, clichés, catch-words

What is a slogan? 'A brief striking phrase', as defined in Webster's dictionary. A phrase, therefore, whose purpose is not to inform, to enlighten or even to order, but to 'strike' people so as to goad them into action. 'No smoking' is an order; 'No smoking . . . even an X cigarette' is a slogan. A slogan can be a sentence, but it may be no more than an expression or syntagma, like 'Let's democratize education', 'Schooling through living', or 'Learning to learn'; in educational theory, these expressions are like kernels which retain their impact in any context. Anyone who said, for instance, 'I'm not in favour of schooling through living', 'We are against the democratization of education', or 'You have no right to learn how to learn', would be discredited; he would be thought offensive or ridiculous. The primary function of slogans is to strike, a function admirably illustrated by the German term *Schlagwort*.

A catch-word is not unlike a slogan proper; while it may not be a phrase, it is nevertheless, 'striking'. In other words, a catch-word not only has a meaning, but exerts power; and perhaps the less meaning it has, the greater the power it exerts. Thus, in some educational circles, words such as 'growth', 'autonomy', 'creativity' are immediately thought of as laudatory, while others such as 'restraint', 'imitation', 'models', 'repression', 'guidelines', appear to be completely pejorative; they can only be used for disparagement. Yet those who use these terms are rarely capable of defining them, as illustrated in this anecdote: a ski instructor was complaining to a mother about her son's pranks. She answered him: 'Please don't hesitate to exercise your authority.' 'But, Madam, authority has no place in our teaching methods.' 'Well, be firm with him, then.' 'Oh, I completely agree with you on that point. You've found just the right word for it!'

Clichés, at least, those, that have their own power of persuasion, are also related to slogans. They, too, are phrases that are concise and easy to repeat: '*Mens sana in corpore sano*', 'Culture is what is left when you have forgotton everything else'; the thought underlying such expressions has been trapped, imprisoned by the expressions themselves, which have become so set that trying to change a single word in them would be like wanting to change a phoneme in a word. The only difference is that clichés are not striking phrases; their impact, on the contrary, is due to the fact that they are so commonplace. Slogans work by surprising people—by the repetition in 'Learning to learn', for instance—whereas clichés affect us because they are so obvious. But the distinction between them is blurred, and every slogan ends up as a cliché.

The important point is that slogans, catch-words and clichés have power, as well as meaning; power to rally people for or against, to persuade them and to justify a particular practice or denounce it. How can this power be accounted for? In my view, it is based on the very nature of a slogan.

The characteristics of slogans in educational theory

Slogans—and from now on, I shall use the word in its wider sense, encompassing catch-words and clichés—are always a mark of commitment to something. Slogans in education are not used in the interest of a firm or a political party, but in those of a 'cause', and they can be classified according to the causes they serve.

Some serve the cause of traditional educational theory, for instance: 'Education always involves a certain amount of discipline.' Others serve the cause of innovation, of what is called the New Education: 'Schooling through living' and 'Learning to learn', for instance. Others again are used as fuel for protest, whether political protest—for instance, 'Education serves the ends of the dominant ideology'—or strictly educational protest: 'Teaching kills learning.' It should be noted that it would be absurd to translate this statement (made by Rogers) into French as '*L'Enseignement tue l'apprentissage*'; something like '*Enseigner empêche d'apprendre*' ('Teaching impedes learning') is needed. This, by the way, shows that slogans, like proverbs and witticisms, generally defy translation.

The fact remains that all these sayings are slogans, whatever cause they support, and if we examine their nature, we can perhaps account for their power.

Slogans always tend to conceal themselves so as to be taken for something else, and this is still truer in education than in advertising or in politics, where propaganda cannot readily mask its true nature. In educational theory, phrases such as these are regarded as principles, demonstrations, truisms based on fact or reason—as anything, in fact, but slogans.

Slogans are anonymous phrases. The person who wrote 'Culture is what is left . . .' did not realize that he had said anything remarkable; everyone has forgotten his name. The fact remains that anonymity adds to the impression of obviousness created by slogans; they do not express 'what so and so thinks', but rather 'what is true'.

Slogans are polemical. The term actually comes from a Gaelic term meaning a 'tribal war cry'. If slogans are rallying cries, they always rally people against something. If slogans assert something, it is always in opposition to another assertion. When people speak of 'growth', it is usually in protest against authoritarian teaching methods, if not all teaching methods; 'what is left when you have forgotton everything else' contrasts culture with erudition, or even knowledge. An American slogan such as 'We teach children, not subjects' is clear in so far as it questions the validity of the sort of teaching that sacrifices the children's mentality, their needs and expectations, to the subject taught; but it is vague in what it asserts: Is it possible to teach children without teaching them something? On the other hand, there is Joubert's observation: 'Plato does not set out to teach anything, but he does teach.' This statement, however, is not a slogan; far from being polemical, it is open-ended, because it makes us stop and think. A statement can be said to be a slogan when the thought behind it is a weapon.

A slogan is not necessarily deceptive, even in politics or in advertising, but it must be brief, both in what it states and in what it stipulates. 'Knowledge is riches'—quite possibly, but what does 'riches' mean? Is it to be understood literally or metaphorically, or both at the same time? People say, 'We must train children who are not only normal, but set the standard'. But what does 'the standard' mean in practice, and how can one attain such an ideal?

Lastly, slogans are not 'hollow' or 'devoid of meaning', as people too often think. In my view, slogans have too many meanings. They are essentially ambiguous, that is to say, they can have quite different meanings according to the speaker or the person spoken to. I once asked two schoolmistresses at a conference in Africa if expressions that were fashionable in their country, such as 'The people's school' and 'A happy school', had the same meaning. They told me that they did, but then an official from the Ministry of Education burst out: 'Of course not, my friends, they are quite different!' Technically, he was right, but the two schoolmistresses did not see things from the technical point of view. They thought both expressions were a condemnation of present-day schools, inherited from colonialism. The theme of the conference was 'Education and Productive Work'. All the participants were agreed on associating the two terms, but what was 'productive work' supposed to mean? Some thought of it as manual work, others, as any wealth-creating work, including the work of artists or . . . teachers. Some saw the actual connection between school and work as synonymous with active methods ('a happy school'), whereas others, thinking of the Soviet model of the polytechnic school, took it to mean linking education with production; but how? By making each school a production unit, or by sending the pupils to work in the fields and in factories?

Slogans, therefore, are evasive, polemical, anonymous, brief and ambiguous. And I do not think that these features are accidentals, or that a slogan could exist without them. They are the very essence of the slogan and account for its power. In fact, these features stem from a more fundamental characteristic. Let us go back to the dictionary definition: 'a brief striking phrase'. The definition, as such, is pleonastic, for any phrase is 'a brief unit of expression'. It would be preferable to say that a slogan is not only a brief phrase, but a phrase which is too brief for the meaning it conveys; it is an instance of what I have referred to elsewhere as 'short-cut rhetoric'. Take the slogan—which has become a cliché—'Teaching is a vocation'; it is not untrue, but the phrase is so short that it is superficial and ambiguous, for it is not clear whether 'vocation' has a literal or a metaphorical meaning. Its brevity makes it a rallying cry—'we teachers are different from others'—and an instrument of polemics, a weapon in the arsenal of the civil service—'you are teachers, and you cannot indulge in basely material demands'. The compressed nature of a slogan is the reason for its power: the power to rally, to denounce, to justify, to persuade. If a slogan were longer, it would not only be less 'striking', not so easy to repeat, but it would no longer be pithy or ambiguous. Its polemical nature would be more noticeable, and attempts would be made to find out who first uttered it. If a slogan were longer, it would cease to be a slogan.

To lend further weight to this brief analysis, I shall apply the same reasoning to two slogans widely used in education.

'Schooling through living'

In order to test the ambiguity of one of the most commonly used phrases in education, I asked my education students to take a sheet of paper and write what they thought 'Schooling through living' meant, each student being allowed to give several meanings, if he thought fit. When I read through their answers, about a hundred in number, I noticed that many of them had not realized that the phrase was a slogan. They were merely trying to answer the question 'What is the role of the school in life?' some seeing it in terms of the life of the individual and others in terms of the life of the community. Those who saw that the phrase was both optative and polemical gave it a variety of meanings, which can be classified as follows.

Life as a school. This is the utopian and violently anti-establishment meaning, based on the ideas of Ivan Illich: 'Education in fields and in places other than school', wrote one student. 'Learning from what we experience means school through life, which means the school of life.' Others, who were more cautious, thought the phrase was synonymous with lifelong education: 'Educating oneself is a never-ending process'; 'School goes on throughout one's life'; lastly, there were those who thought it merely a synonym for education, but in opposition to schooling: 'Life is something that has to be learnt; life is education in the broadest sense.'

Life in the school. Schooling through living implies a school that is alive, that encourages participation, initiative, practical experience, 'so as to re-create in school the conditions of life outside and the conditions of genuine exchange between people'. This involves using active methods, 'so that every individual's imagination and powers of expression will have free rein'; 'a school that does not separate intellectual from manual or practical work'; or, more succinctly, 'learning what we like'. To put it briefly, those who understand the term in this way do not think that life should be sought outside the school, but that 'life should be brought into the school, from which it is now conspicuously absent'.

The school open to life. In this case, it is not the methods that are to be changed, but the content; the nature of the teaching is not to be changed, but 'the school is to be integrated into the environment'; 'the school must be prepared to be brought into question by the changes in society'; 'it must interact with the environment'; schooling through living, therefore, means that 'the school must open its doors to the outside world and even become part of the world'. Some answers were more detailed: 'School syllabuses should meet the requirements (economic, social, etc.) of the modern world'; 'students should be made aware of current affairs, such as politics, or hunger in various parts of the world'. It should be noted that, although these proposals do not exclude active methods, they do not necessarily include them: it is possible to give a lecture on hunger in the world.

School for life. This means that education should really prepare children for life. But in what way? First of all, in a practical way: 'Learning about real life: learning a trade, developing a critical attitude to the media, dealing with daily human relations'; 'vocational guidance, knowledge of different trades, job openings and careers'; a school that teaches about 'how life is organized in a community (postal and banking services, finance, political responsibilities and those linked with the life of associations)'. Secondly, in a more social way: 'giving pupils an idea of how to live in a community';

'developing the basic personality'. Lastly, in a more general, vague and indeterminate way: a school 'which teaches students how to live', which imparts 'knowledge to be used in life and not for the students themselves'; 'learning about life and all that it implies'.

So people such as these, who are educated and have already had some specialized training, discern four possible meanings of the phrase 'schooling through living', each of which can be broken down into secondary meanings. Many of these meanings, admittedly, are assimilable or complementary, but they may also be in contradiction with each other; for example, 'bringing life to the school' and 'learning to live outside the school'. Under the same heading—life in the school, for instance—there are ideas with conflicting implications: Can 'learning what we like' be compatible with 'a school that does not separate intellectual from manual or practical work'? For it is quite likely that a particular student will not be attracted to any one of these three types of work? Generally speaking, some think that life teaches us, others, that life has to be learnt.

In the last resort, what gives the slogan its unity, its power to persuade and incite, is not what it asserts, but what it rejects: 'an education that is ossified, academic, cut off from life, out of touch with the environment'; 'ossified, doctrinal and castrating'. It is true that in all these answers life is the ultimate criterion, and the school enjoys approval only in so far as it meets that criterion: 'The school should not destroy the spontaneity of what is alive.' What, however, do 'life' and 'in' mean? They have so many meanings that they mean very little. It is the brevity of the slogan which makes it a rallying-cry. There is nothing like ambiguity for generating unanimity.

'Democratizing education'

Once I had talked to the students about their answers, I undertook the experiment again, a fortnight later, with the phrase: 'Democratizing education'. This time, however, the students were more knowledgeable on the matter and more wary, and they all realized that it was a slogan. Some even said it was inadmissible, for five reasons: (a) 'To democratize is a political term which should not be applied to school: the verb suggests that the school can be subjected to anything at all; (b) the phrase is in contradiction with [illegible]ality: 'The genetic code makes human beings unequal at birth'; (c) 'Democratizing' is a demagogical expression, which leads to 'the levelling down of human beings' and to the 'decline of education standards'; (d) 'Democratizing' is a hollow term, whose sole purpose is to reassure the public and the teaching profession—'it's a get-out'; (e) if we try to democratize the school, we may achieve the opposite of what we wish: 'Pupils would have a share in authority, but how would they use it? This is fine if we want to train children to be little tin gods'; 'if you treat everybody alike, those who are already underprivileged will be at an even greater disadvantage'.

Most of the students nevertheless, approved of the idea, but stressed its utopian character: 'An unattainable utopia, but the idea is interesting'; 'understandable and enriching'. Why is it Utopian? (a) because society itself is anti-democratic; (b) because 'the teaching would have to be objective, and that would be in contradiction to the personality of teachers'; (c) because school is a fundamentally authoritarian institution, and, as such, 'cannot question its own validity'; (d) because life in the community 'is not educative to the same extent for all, and the social environment is often unfavourable to the education of the individual'.

Those who approved of the idea, as well as those who were against it, gave it five very different meanings:

A traditional meaning, such as it might have had under the French Third Republic. Democratizing means doing away with privileges, such as 'those related to the family or to money'. Consequently, education must be: (a) identical, 'the same for all'; (b) egalitarian, assessing pupils objectively, 'accepting the fact that children from the upper classes can be dunces'; (c) free, 'at all levels', indeed with grants for 'the most necessitous'; (d) compulsory, 'by virtue of the right of the individual to education'; (e) an encouragement to social mobility, with equal opportunities for all; (f) secular—but there was a certain divergence of opinion on this point; some of the students thought that being secular meant being objective and neutral; others thought it meant pluralism, 'for only by letting the widest spectrum of ideologies' into the school, 'can objectivity be attained and the pupils' powers of criticism developed'. Oddly enough the students who gave these answers did not see—or did not say—that 'democratizing education', understood in that sense, was in no way utopian.

A social, even socialist, meaning: 'democratizing education' means opposing not only privileges but anything in school life that could lead to the emergence of an élite. This would require much more radical measures than the previous ones: for instance, adapting to 'the linguistic level and affectivity of underprivileged children', 'eliminating from education all that stems from bourgeois domination (language, culture, moral and ideological values)' even if it meant 'exposing' the children of middle-class parents 'to failure'; or ensuring that 'the various social classes are represented in higher education in proportion to their numbers', even if a *numerus clausus* has to be resorted to. Ultimately, there is a contradiction between the ends: 'providing the same education for all', and the means: 'not providing the same education for all', so as to make up for inequalities due to social origins.

An educational meaning. 'Democratizing education' is not only giving everyone the benefit of education, but rather 'transforming the structures of education so as to turn it into a democracy'. All the answers of this kind are opposed to the authoritarianism of schools today, but they differ as to the solutions. To democratize is: (a) to free teachers from the authority of the administrative hierarchy and the stranglehold of syllabuses; (b) to free pupils, either through joint management ('sharing knowledge and power with the children'), or through self-management, the pupils as a body taking all the decisions; (c) to modify syllabuses so that they are not, as heretofore, 'focused on the past, on abstraction, on Western culture and on the written word', 'so as to take account of what the pupils want'; (d) to introduce different teaching methods which stress experience and group work; (e) to adopt fresh aims in education, so that each student 'can realize his full potential', 'so that the lover of plants can become, not a pen-pusher, but a gardener'.

An anarchical meaning. Democratizing school would make it optional and would mean that anyone could teach; it could even mean the disappearance of school and its replacement by the education that life can give.

A political meaning—the least common. 'To democratize teaching' is to turn it into the teaching of democracy, by providing 'the means by which everyone can learn to live in a community'; 'pupils must therefore play their part in the political life of the community by voicing their opinions'; a more radical idea is 'to make education the tool of a revolution in the institutions of society, so that a true democracy could be set up'.

In short, this phrase, like the previous one, certainly has the characteristics of a slogan: it is anonymous, polemical, brief and ambiguous. This does not mean that it is either deceptive or harmful in its effects, but merely that it is a slogan, and all the more so as the fact that it seems so obvious and so familiar that it tends to conceal its identity. It may well be an intellectual stereotype, a ready-made idea which spares us the trouble of thinking for ourselves. Does this mean that educational slogans should be outlawed?

Can we do without slogans?

It seems to me impossible to answer 'Yes' or 'No'. Although it can be said that any slogan encapsulates a political or educational theory by expressing it in a striking way, the above analyses show that the ideas which the slogan is supposed to summarize differ profoundly, even if they are not mutually contradictory. A slogan is not so much a summary as a 'short-cut' expression which tends to gloss over difficulties and contradictions. As if utopia were getting its own back on life, the slogan is, in fact, an 'Open, Sesame!', a magical phrase. This is why it is irreplaceable.

Some slogans, admittedly, seem to be objectionable because by their very content they betray the cause they are supposed to be defending. What of the expression: 'Teaching is transmitting knowledge', which seems obvious enough to both traditionalists and their opponents alike? The former maintain that teaching means transmitting as faithfully as possible the knowledge and values which make up the social and human heritage. To which the latter reply that the 'academic knowledge' which a student is expected to acquire is nothing but a dead weight on him, which means that 'his desires are suppressed and his creative impulse dampened'. However, neither those for nor those against consider whether knowledge can actually be transmitted to others. The metaphor, with its technical connotations, seems to me unfortunate. For transmission is a passive process: a sentinel who transmits a message does not need to understand it, any more than a machine would. Worse still is the fact that transmission of a message always leads to the diminution, the gradual blurring, of the initial information. If teaching means transmitting, then it is prejudicial to the pupils, whom it forces to learn without understanding; and it is prejudicial to knowledge, which it transforms into dogma, or even into verbalism. Knowledge that is transmitted loses its force. A mathematics teacher does not 'transmit' an understanding of a theorem, nor does an English teacher 'transmit' an understanding of a literary work. A statement such as this does not define education, but destroys it.

Other slogans are dangerous not because of what they say but because of what they do not say. Let us take, for instance, the fashionable slogan, 'learning to be'. What it says is excellent, that the purpose of education is to produce a well-rounded personality. But it is dangerous in what it does not say:

It is mostly used in a polemical way: learning to be rather than learning such and such a thing; under the pretext of standing up against intellectualism, a slogan of this kind is likely to attack intellectual life—but that, too, is part of our 'being' as human beings!

It suggests that 'being' can be learnt in school, just as one can learn physics or modern languages; it therefore goes to the other extreme, educational imperialism; it is up to every individual to learn to be—to learn to love, to grow old, to understand, to educate—and this is a lifelong task. Education can prepare him for this task, but cannot perform it instead of him. Because 'learning to be' sounds good, we are tempted to make a magician's spell of it.

Whenever any educational theory is in conflict with other theories, it is difficult to see how it can do without slogans, especially as its conflict with other theories is not only on a theoretical plane but also on a practical one, and still more on an affective one. The best of causes would be defeated from the outset if it could not use these striking phrases which express the passionate conviction of a group of people better than any lengthy discourse. Is this a pessimistic conclusion?

I think not. A passion that is expressed is a passion whose nature we know or, at least, can get to know. Here lies the real value of the slogan. Analysing it opens up a world of differing meanings, of thoughts, mental reservations and passions. To discover this is to progress. The African conference, referred to earlier, was truly fruitful in that participants realized all the ambiguity of the slogan 'education and productive work'. 'Schooling through living' and 'Democratizing education' gave rise to a fruitful discussion with our students, once they had realized how ambiguous yet how rich in meaning their answers were. Ready-made ideas are dangerous, but they can provide food for thought.

Of course, one must realize what such ideas are. A truly dangerous slogan is one that does not seem to be a slogan, but hides under the guise of common sense, venerated tradition, revolutionary demands or scientific fact. When this happens, language, in education as elsewhere, no longer expresses thought, but suppresses it.

Further reading

Olivier Reboul, *Le Slogan*, p. 47, Paris, Complexe/PUF, 1975. On slogans in education, cf. ibid., p. 101 et seq. See also B. P. Komisar and McClellan, 'The Logic of Slogans', *Language and Concepts in Education*, Chicago, Smith, 1961; Israel Scheffler, *The Language of Education*, Springfield, Ill., Thomas, 1960; Viviane Isambert-Jamati, *Crises de la Société, Crises de l'Enseignement*, Paris, PUF, 1970.

Elements for a dossier

Mathematics for real life

Max S. Bell

Teaching mathematics as a tool for problem-solving

The teaching of mathematics has long been a major emphasis in school, but always with considerable debate about its content and effectiveness. Since at least 1900 that debate has resulted at about twenty-year intervals in serious 'reform' recommendations, each followed by considerable effort to create new curriculum materials or better teaching methods. These intense periods of reform are typically followed by a decade or so in which the reform materials are in part absorbed, in part abandoned, and in part become obsolete as advancing knowledge and the needs of society present new demands. The most recent of these reform periods, in the late 1950s and early 1960s had as its result the much heralded and much maligned 'new mathematics'. Those reforms were aimed chiefly at rooting out bad mathematics and obsolete topics from school-books and making appropriate mathematical structures the basis for teaching at all school levels. The reforms had significant and largely positive effects on secondary school mathematics, and especially on college preparatory courses. But at least in the United States the reforms had little effect of any kind, positive or negative, on the elementary school arithmetic experience. Elementary school-books changed some, but in the overwhelming majority of schools the actual classroom experience did not change, probably because little was done to help teachers understand and teach the new emphases that were proposed. Both before and after the reforms the nearly exclusive emphasis in elementary schooling was on the arithmetic of whole numbers, fractions and decimals, with little concern for uses of that arithmetic.

As we now approach the 1980s there is again a rising level of concern about the effectiveness of school mathematics instruction, and we can probably expect that yet another reform movement will result. Such new reforms are very much needed, not necessarily because of 'failure' of past reforms but because new needs and new opportunities have developed in the twenty years since 1958 and these must be attended to. Most prominent among these is the increasing need to 'teach mathematics so as to be useful', to use a phrase of Hans Freudenthal, not merely to a few people but virtually to everyone. Closely allied to that is the need to accommodate to the now nearly universal availability of powerful and relatively inexpensive calculation and computer power. Those two needs in turn generate a pressing need to sort out what really constitute 'basic skills'. That is, what is really important to know in order to use mathematics

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in problem solving if calculation as such is easily accomplished even when it is quite complex.

Over the last few years an enormous amount has been printed in the pedagogical and technical literature and in popular journalism about those issues. The following can be taken as a summary of a large part of that literature and also as a series of assumptions on which the arguments of this article are based:

A sound mathematical base including much more than mere calculation skill has become important (and often essential) to people in many sorts of personal and professional pursuits, and this trend for more people to need more mathematics is nearly certain to continue. Hence, mathematics education must not only provide for competence in dealing with numerical information but must also provide a basis for learning more specialized mathematics and statistics for whoever comes to have such needs.

Judged by those needs, the school mathematics experience is a failure for large numbers of people—probably a majority. That is, many people openly express feelings of fear and inadequacy with respect to using mathematics. Also, recent nation-wide assessments of competence in mathematics in several countries show that although most adults can do arithmetic accurately, it often happens that a majority cannot cope even with standard consumer applications of arithmetic, let alone more complicated uses of mathematics.[1]

For adequate understanding of mathematics and good feelings about it, excellent and rich instruction must begin in the years before high school, and probably in the primary school grades. In addition to the self-evident importance of 'a good start', it may be that certain learnings of children happen best or even only in the developmental stages represented by those childhood years. But primary school mathematics is often quite sterile and even with best of intentions, most teachers in the pre-high school years feel unable to change that—certainly we have not prepared them to do so.

One factor inhibiting change in the elementary school experience has been and continues to be the intense pressure on teachers to improve 'test scores' of the youngsters they teach by emphasizing 'basic skills', which always mean computation skills. However we or they may feel about such an exclusive emphasis, teachers receive little competing advice about what in addition to that is 'basic'.

In direct contrast to that demand for almost exclusive emphasis in elementary school on calculation skills, recent and continuing dispersion of inexpensive electronic calculators means that within a few years the doing of arithmetic will be very different for most people than it has been in the past. At the very least this calls into serious question a narrow emphasis exclusively on calculation. Perhaps more important it makes possible new emphases in the mathematics learning experience that are not familiar to most teachers.

Those seem to be the main facts confronting us as we consider again what should be the mathematics learning experience in the 1980s: more people need to use mathematics than ever before but the majority of people are unable to cope even with the simpler uses of arithmetic; changing that would require among other things an excellent primary school experience, but we have not made teachers equal to that task; teachers are urged to give nearly exclusive emphasis on teaching calculation skills just as it seems apparent that calculation skill as such will not be a prominent need of most people a few years from now. The remainder of this article will suggest some ways to deal with these facts.

What is 'basic' in mathematics learning?

Following the substantial but partial successes of the 'new mathematics' reforms of the 1960s there has been the usual period of consolidation and adaptation of those reforms. Schoolbooks regress a little each year back towards the pre-reform norms and those who have always felt that the old ways are better than the new ways now occupy the field with a 'back to basics' battle cry. Hence for the past five years or so there has been a heated debate about what those 'basics' might be and that debate is still going on.

In one publication in which thirty-three mathematicians and mathematics educators each try to define what is basic in school mathematics, James Fey makes the point that such definition is difficult because so many meanings are attributed to the word 'basic'. He observes that if that means the minimum to survive in society it should be a very short list of skills—most people do in fact survive and most people do not know very much mathematics. He observes that the skills needed to be an informed consumer constitute a more demanding but still quite narrow list. In any case, he says, both the 'survival' and 'consumer' definitions for basic skills are too pessimistic about the potential of school mathematics. Instead we should focus on the 'mathematical abilities sufficient for effective citizenship and ability to comprehend the social and technological environment'. Besides being a more worthy and less pessimistic way of proceeding that also 'yields insight into the research and development needs in mathematics instruction'.[2]

Most existing lists of basic skills for school mathematics are indeed much too narrow and much too pessimistic and, in addition, the skills they insist on are far from adequate in solving the problems presented by today's world. But even the most narrow of these lists gives lip service to 'problem solving' so this is one point of agreement around which everyone can rally.

There is difficulty in the fact that 'problem solving' means many different things, from trivial puzzles to advanced mathematical research. But it is easy to detect what 'problem solving' means to those most thoughtful about what school mathematics should accomplish, as indicated by these statements that span more than half a century:

> Problem solving in school is for the sake of solving problems in life. Other things being equal, problems where the situation is real are better than problems where it is described in words. Other things being equal, problems which might really occur in a sane and reasonable life are better than bogus problems and mere puzzles.[3]

> Since mathematics has proved indispensable for the understanding and the technological control not only of the physical world but also of the social structure, we can no longer keep silent about teaching mathematics so as to be useful. In educational philosophies of the past, mathematics often figures as the paragon of a disinterested science. No doubt it still is, but we can no longer afford to stress this point if this keeps our attention off the widespread use of mathematics and the fact that mathematics is needed not by a few people but virtually by everybody.[4]

> Mathematics is a lot of fun for a small number of individuals. For even a smaller number mathematics provides a profound aesthetic experience. If that were the whole story it would not be possible to justify the emphasis given to mathematics in our school programs. The real justification for teaching mathematics in our schools is that it is a useful subject and in particular, that it helps in solving many kinds of problems.[5]

Here in addition is one of countless testimonies from users of mathematics:

> The use of mathematical language . . . is already desirable and will soon become inevitable. Without its help the further growth of business with its attendant complexity of organization will be retarded and perhaps halted. In the science of management, as in other sciences, mathematics has become a 'condition of progress'.[6]

The plain fact is that the ability to use mathematics has become a 'condition of progress' not only for business and for almost all of the natural and social sciences but for individuals as well. In recognition of that a recent editorial in *Science* magazine (19 January 1979) deplored the 'high school mathematics screen' to the further progress of millions of students who drop out of mathematics too soon. But that mathematics screen probably operates well before high school and as I indicated earlier it may have its origins in the primary school years. The task is to help children gain the confidence and well-founded intuition about numbers, computation, geometry, probability, logic and so on that makes them able and willing to take on and master each new mathematical task. For many people that seems not to be so now, but it would be fruitless to try to assess blame for that. In particular, we should not point accusing fingers at teachers and further erode their confidence, for they are working with the inadequate training, the narrow expectations, and the sterile materials that we have collectively provided for them. If that has failed children, then we have failed teachers.

Rather than look backward at the inadequacies of school mathematics let us look forward at how it can be improved. If we can agree that one of the main imperatives is to teach mathematics so as to be useful, then a first step is to find out how mathematics is used by people good at doing so and then to identify the mathematical content teachable in schools that will be helpful to most people in making them better at using mathematics. We turn next to those tasks.

Objectives for a learning experience that emphasizes the uses of mathematics

If we are to make the linking of mathematics to its uses our main aim in schooling we should first seek to understand the processes by which mathematics is applied by those skilled in doing so. Since about 1940 many more people have been led to use mathematics in many more places and during that same time we have achieved greater clarity about how that is achieved through the formulation and use of so-called 'mathematical models'. A colourful brief description has been supplied by the applied mathematician John Synge:

> The use of applied mathematics in relation to a physical problem involves three stages: (1) A dive from the world of reality into the world of mathematics; (2) A swim in the world of mathematics; and (3) A climb from the world of mathematics back into the world of reality, carrying a prediction in our teeth.[7]

More detail about the various steps in applying mathematics is suggested in Figure 1 which shows that situations in the real world are almost always very complicated so one works toward simplification, abstraction and representation by mathematical symbols. That can happen in as simple a way as counting objects in several collections and replacing the collections themselves by the numbers representing their counts. Sometimes the process of analysis and abstraction leads to solutions of the problem without very much use of mathematics. But often it is necessary to take those abstractions and work with them in mathematical ways, indicated by the box at the bottom of Figure 1. That mathematics work can be independent of the real world source of the problem, indeed, the fact that the same mathematical techniques can be applied in many situations is one thing that gives mathematics its considerable power in problem solving. When the mathematical work has given some specific results then those results must still be subjected to interpretation in the real world, as indicated by the arrow to the right of Figure 1. Several such interchanges between the world of mathematics and the rest of the world are the rule for most moderately complicated real-world problems.

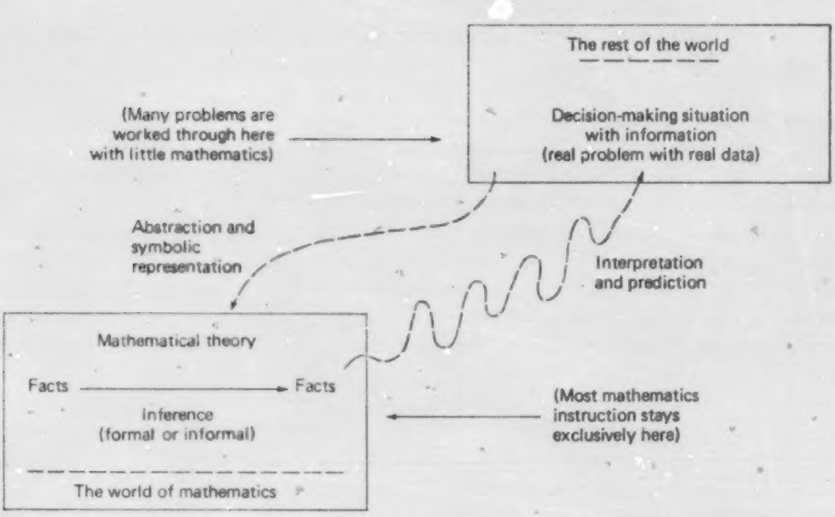
The rest of the world
Decision-making situation with information (real problem with real data)
(Many problems are worked through here with little mathematics)
Abstraction and symbolic representation
Interpretation and prediction
Mathematical theory
Facts
Facts
Inference (formal or informal)
The world of mathematics
(Most mathematics instruction stays exclusively here)

FIG. 1. A short course in 'mathematical modelling'. *Source*: J. T. Fey, 'Remarks on Basic Skills and Learning in Mathematics', *Conference on Basic Mathematics Skills and Learning*, Vol. 1, Washington, National Institute of Education, 1975.

Since the process just described has proved to be extremely fruitful in making mathematics useful in many problem-solving situations, we should perhaps take account of it in formulating objectives for teaching mathematics so as to be useful. Below, I have tried to indicate by a list of topics what is useful to most people and I have tried to organize that list in a way that reflects the mathematical modelling process. Hence, skills related to abstraction and symbolization are listed first, then skills primarily needed in doing mathematics as mathematics, then skills needed in using mathematical information from whatever source in interpretation, prediction, or decision-making. There is, of course, overlap among the three main categories.

A. Building mathematical models: quantification, representation, abstraction

1. Notation and symbol systems: (a) seek efficient notation; (b) variables as 'shorthand' or as 'placeholders' for numbers.
2. Non-calculation uses of numbers: (a) counts; (b) measures; (c) ratios; (d) co-ordinates; (e) ordering; (f) indexing; (g) coded information; (h) identification numbers.
3. Descriptive statistics—representing numerical data sets: flexibility and inventiveness in display of data for single variables—tallies, tables, histograms, graphs, etc. Also useful: (a) two variable scattergrams; (b) sketch best fit line or curve.
4. Visual displays—representing non-numerical information: (a) attention to fine detail; (b) sensitivity to forms; (c) plane geometry figures; (d) diagrams such as blueprints, circuits, machinery parts, etc.; (e) graphs showing relationships, e.g. arrows, branching; (f) co-ordinate systems to show locations. Also useful: (a) Venn diagrams; (b) flow charts.

5. Translation skills: flexible translation among verbal statements, equations, formulas, tables, graphs, etc. Also useful: induce simple rules from regularities.

B. Work mostly within the world of mathematics

1. Basic number skills: (a) plain and fancy counting skills—forward, backwards, by tens, etc.; (b) operation 'reflexes' with single digit numbers. Also useful: (a) arithmetic of powers of ten and scientific notation; (b) arithmetic of proportions.
2. Relations: (a) standard equivalence relations—equal, congruent, similarity; (b) shrewd choices or substitutions from equivalence classes, e.g. use 1/2 or 3/6 or 50 per cent or .5 or whatever as convenient; (c) other relations—less, greater, perpendicular, parallel, subset.
3. Numerical computation: (a) algorithms for standard operations—conceptually revealing or 'low stress' or exploiting counting whenever possible; (b) intelligent use of calculators or computers.
4. Skilled use of variables: (a) manipulations within equations to point of reflex; (b) functions, relations, formulas; (c) substitution. Also useful: (a) systems of equations; (b) parameters.
5. Relations, functions, mappings: (a) intuition about input-output formulations and constraints on inputs or outputs; (b) linear function as equations, tables, co-ordinate graphs. Also useful: standard equations, graphs and properties of linear, quadratic and exponential functions.
6. Basic logical skills: (a) importance of agreed-upon starting-points—axioms and undefined words; (b) need for precise definitions; (c) proper use of quantifiers—all, there exists, some, etc.; (d) valid but possibly informal deductive arguments.
7. Geometric relations: (a) intuition about standard plane geometry properties through congruence, similarity, Pythogorean theorem; (b) intuition about co-ordinates and transformations as alternate approaches to geometry. Also useful: projections as applied to perspective drawing, contour maps, or representing the world on flat maps.

C. Decision-making with either mathematically derived or real-world information

1. Fundamental measure concepts: (a) pervasiveness of measure as a source of numbers; (b) role of 'unit' and 'standards of measures'; (c) intuition about magnitude of standard units—metre, gram, etc.; (d) measures as approximations; (e) reliance of data on quality of measure instruments. Also useful: 'variation'—from the measure process or from change of things being measured.
2. Measures and their compounds: (a) fundamental measures—length, mass (weight), temperature, time; (b) common compounds, e.g. area, volume, capacity, speed/velocity, density; (c) variety of other compounds, e.g. medical measures, clothing sizes, acceleration, pressure, etc.; (d) relations among units in a measure system. Also useful: (a) dimensional analysis as used in physical sciences; (b) arbitrarily defined 'indexes' as measures: e.g. cost of living, inflation.
3. Confident and informed use of estimates and approximations: (a) 'number sense'; (b) 'measure sense'; (c) round off and calculate with easy numbers and powers of ten; (d) rules of thumb; (e) standard conversion factors; (f) reasonable cost or amount in many situations. Also useful: (a) order of magnitude estimates; (b) guess and verify methods.
4. Probability based measures: (a) uncertainty exists—probability as a 'measure' of it; (b) prediction of mass behavior versus unpredictability of single events; (c) theory-based versus experience-based probabilities. Also useful: sampling considerations.

5. Simple uses of statistics: (a) flexibility and variety in display of data; (b) standard averages—mean, median, mode; (c) 'spread' or 'variance' in data; (d) flexibility in seeking relationships among data; (e) scepticism about 'causality' in correlated data. Also useful: simple tests of 'unusualness' of a result, e.g. chi-square test.
6. Computer awareness: (a) capabilities of computers; (b) limitations; (c) awareness of human control.

Most skills and ideas listed above can profitably be begun even in first grade and carried to higher levels in subsequent grades.

In order to indicate how such a list could guide creation of a school curriculum aimed at more skill in solving real problems with real data let us consider how some of the topics in that list could be dealt with in the primary school years. (Of course, those primary school beginnings should be extended in later school years.) To begin with the first things on the list, children can be asked quite early to try to invent good ways of using abbreviations and symbols and they can soon learn that our standard number system is a very efficient way to represent things that matter to them. Variables are already introduced into many primary school mathematics books by the use of 'frames' in such equations as $3+\square=7$. To move to the second thing on the list, children can easily be alerted to many uses of numbers in their real world. For example, there are countless opportunities for counting and measuring. To turn to other non-computational uses, a child might be led to notice that a number on a schoolroom door such as 213 really conceals a pair of numbers—room number 13 on the second floor of the building. Notions about numbers as co-ordinates and the role of numbers in indicating in what order things come could be started by asking a child to try to make sense of the house numbers on the street where he lives. As other examples, might we not alert children to the pervasive use of numbers as identification codes; for example, licence plates, telephone numbers, postal codes, road classification numbers, etc.? Might we make something of 'take a number' in bakeries and other places to impose a fair order of service on a crowd of customers? Can we also ask where it might *not* be appropriate to impose an order of service based on arrival time—in a hospital emergency room, for example?

With respect to simple data display (A3 (a) above), we have enough suggestions in the early Nuffield mathematics materials to make clear that the child's actual experience provides ample material to be exploited here.[8] With respect to visual displays (A4) much can be accomplished simply by making children sensitive to decorative or other details and geometric forms in their environment. One can also expose children as often as possible to diagrams, scale drawings and the like, especially of familiar places and things. The books of the Nuffield mathematics project as well as the work of the Papys give many examples of representational graphs used with children (A4 (e)).[9] There are also many games and practical situations (using maps for example) that illustrate how pairs or triples of numbers can be used to specify location (A4 (f)).

Translation of information among verbal statements, tables, graphs, formulas, equations, and so on are surely very important (A5). Practice in using those translation skills can be built into the school experience from the very beginning, perhaps sometimes as part of reading or social studies lessons. Eventually one should be able to start with information in any of these forms and express it in any of the other forms that may be appropriate.

The second section of the list (B, above) deals with the skills central to using mathematics as mathematics. Since most school work up to now has been devoted nearly exclusively to that, ideas for teaching in that area should be easy to generate. But it cannot be emphasized too strongly that even here the work in mathematics should often be tied to some problem-solving situation—work done for some purpose meaningful to children. Also, the emphases in this teaching probably need to change. For example, having really excellent counting skills would also make children very good at doing most whole-number arithmetic without very much use of paper and pencil and would also make them much better with some important estimating skills. Just as parents reading to children helps them a lot in learning to read, parents playing counting games with children or having them count many things would make arithmetic much easier to learn. (Nearly all parents worldwide could do that if alerted to its helpfulness.)

Turning to equivalence relations and equivalence classes (B2(a) and B2(b)), few people realize how much work in mathematics is accomplished simply by replacing one thing by another equivalent thing. Simplifying equations, work with fractions, and such things as replacing '4+7' by '11' are only a few examples of the power of that idea. To consider numerical computation (B3), nearly everyone who has been in school has been exposed to so-called 'algorithms' ('long division' for example) but we must reconsider the real purpose of these in a world where as a matter of fact anything beyond simple manipulations of numbers will be done by nearly everyone with calculators or computers. Intelligent use of calculators (B3(b)) requires more rather than less feeling for numbers and the meaning of operations. Questions about what operations to use, when to use them, and intuition about whether the answers obtained make sense have always been important issues. But they have also been neglected and with the sheer labour of calculation much less a central issue, it should be possible to focus more strongly on them.

To comment on a few more of the things listed, skill in manipulating expressions containing variables (B4(a)) is probably nearly as important to real comfort with mathematics as is knowing the basic multiplication and addition facts as instant reflexes. Work on manipulation as such probably should not start too early in school, but examples of the various uses of variables and practice in substituting numbers for variables can be built into a variety of activities in the early years. Similarly, a complete understanding of functions, relations, or mappings (B5) takes many years to develop but situations that work with inputs and outputs that contain most of the central fonction and relation ideas can be devised for the early school years. As to logic (B6) we all know that most children find it difficult to reason from arbitrary hypotheses but many if not most children have little difficulty with less formal reasoning based on their own experience. For example, children at play do make up arbitrary rules for games and argue through disputes on the basis of those rules. They can also change such rules and then argue from their new 'axioms'. As to geometric relations (B7) many of the new mathematics materials (for example the Nuffield project books) have good exercises in intuitive geometry which, however, have not been used with most children.

We turn now to comments with respect to the third part of the list—the use of mathematical information, however derived, in making decisions in the real world. The first thing to be said is that many of the specific things listed here are also important in the quantification and abstraction process dealt with in the first part of the list. This is certainly true of 'measure', for example, and also of simple statistical techniques. It must also be emphasized that measure plays a central role in much of what all of us do in solving problems in and making sense of the world we live in. Hence, there is probably no more important thing for schools to do than to make a pervasive emphasis on such measure considerations, as listed in C1 and C2, a part of every child's experience. Similarly, estimates and approximations (C3) have been neglected in school work. Children have been taught too well the mistaken notion that in using mathematics *only* exact answers are permisable. As a matter of fact, in problem-solving in the real world it is very often the case that a reasonable approximation is sufficient for making a good decision. Often one only needs to know the order of magnitude; for example, knowing whether the cost of something is tens, hundreds, or thousands of dollars may be enough information for a good decision, and whether the actual cost is $169.97 or $130.47 may be relatively unimportant. With children we should watch for opportunities to ask '*About* how much . . .?' and then 'Why do you think so?' at least as often as 'What is the exact answer?' (Of course, as listed in B1(b), anyone who cannot give exact and instant answers for the basic addition and multiplication facts is crippled in many ways, but those reflexes are not really so difficult to achieve.)

It is not possible here to discuss each of the items on the list given above but perhaps what has been said is enough to indicate why such objectives as those on the list can help people use mathematics in problem solving in their everyday and working lives. Many people will also need more advanced skills than those listed. Such additional skill may be achieved in school but many people will find they need to acquire it after leaving school. In either case, the kind of reality-based experience that would lead to mastery of such things as those listed will also support the learning of more advanced techniques.

Planning for a new curriculum

It will not be easy to change school work in elementary mathematics from its present nearly exclusive emphases on calculation and symbol manipulation to an emphasis on solving real problems with real data. Among other things there will be enormous problems in training teachers and supplying appropriate teaching materials. In making such changes, developing countries may have less difficulty than relatively developed countries, if only because there may be fewer traditions and misconceptions already firmly fixed in the system and suitable teacher training may be easier in an expanding teacher corps than in one that is static or declining.

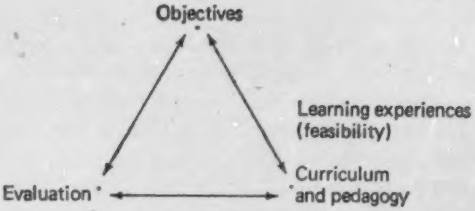

FIG. 2. A short course in curriculum planning.

In any effort to plan for school instruction, such a diagram as that given in Figure 2 is helpful. The problems are always to decide on objectives (what to do), learning experiences (how to do it), and evaluation (what has been accomplished). I have spoken here mainly of objectives, as listed earlier. I do not claim that particular list is the one all must use but I do believe that some such list of outcomes with each to be worked on over several years is a helpful means to planning for the school experience. In particular it is much more helpful than lists containing hundreds of detailed 'behavioural objectives' that, at least in the West, tend to dominate curriculum planning. Teachers can use such a list by asking themselves such questions as 'What have we done in my class this week (or this year) to help children with approximation skills?' 'Can I do anything now to anticipate the need of children later on to use variables?' 'Can I help children see that "chance" is part of life as well as exact answers and thus give them more understanding of probability?' Such a list as that given should be useful in obvious ways in planning for pre-service and in-service training of teachers. That is, if such things as given by that list are helpful to most people, they should be known very well by most teachers. It seems to me that such a list of broader objectives of school mathematics would be useful in educating parents, school boards, and the like about what can and should be accomplished in school mathematics. Such a list can also help us find overlap with other school subjects as teachers with such a list in hand ask such questions as these: 'Can this science lesson help teach about measure?' 'As I teach about maps in geography can I also make some good points about co-ordinate systems?' 'Would this social studies lesson be helped by having children get some information from tables in an almanac?' 'In teaching children to use scale drawings in the shop class can I also make some useful points about "similarity" as an idea?' Such possibilities seem nearly endless once teachers are alerted to what from mathematics can be most useful in real-life problem solving.

Notes

1. National Assessment of Educational Progress (NAEP), *Math Fundamentals: Selected Results from the First National Assessment of Mathematics* and *Consumer Math: Selected Results from the First National Assessment of Mathematics*, Washington, D.C., Superintendant of Documents, U.S. Government Printing Office, 1975.
2. J. T. Fey, 'Remarks on Basic Skills and Learning in Mathematics', *Conference on Basic Mathematics Skills and Learning, Volume 1, Contributed Position Papers*, p. 51–6, Washington D.C., National Institute of Education, 1975, 227 p.
3. E. S. Thorndike *et al.*, *The Psychology of Algebra*, New York, Macmillan, 1923, 483 p.
4. H. Freudenthal, 'Why to Teach Mathematics So As to Be Useful', *Educational Studies in Mathematics*, Vol. 1, No. 1, May 1968, p. 3–8.
5. E. G. Begle, *Critical Variables in Mathematics Education: Findings from a Survey of the Empirical Literature*, Washington, D.C., The Mathematics Association of America, 1979.
6. A. Battersby, *Mathematics in Management*, Harmondsworth, Penguin Books, 1966.
7. J. Synge, Quoted in M. R. Kenner, 'Mathematical Education Notes', *The American Mathematical Monthly*, Vol. 68, No. 8, October 1961, p. 799.
8. Nuffield Mathematics Project, *Mathematics: The First Three Years*, London, John Murray, 1970, 150 p.
9. Frederique and Papy, *Graphs and the Child*, Montreal, Alonquin, 1970, 189 p.

Hans Freudenthal

New math or new education?

About twenty years ago I gave a lecture 'Teaching Modern Mathematics or Modern Teaching of Mathematics'. At that time my reputation was already tainted. It was not the first time that my colleague mathematicians were scandalized and mathematics teachers who listened were confused by the strange behaviour of a research mathematician who cast doubts on teaching mathematics as a codified subject matter and on modernizing mathematics teaching as a matter of updating the subject-matter to be taught to the present state of mathematical science.

Mathematics was the first area of education that enjoyed international co-operation (in the International Commission on Mathematical Instruction, founded early in this century) but up to the 1950s the themes of this co-operation were organization and subject-matter and the prevailing view was that of the university mathematician.

As early as the beginning of this century, Felix Klein had pointed out the tremendous gap between school and university mathematics, although he interpreted it too narrowly, as a mere matter of content. At the end of the 1950s the *Sputnik* shock stirred up distrust of the factual teaching of mathematics and science, which spread from the United States over most of the world. In Europe, the OEEC (the later OECD) caught and passed on the message that mathematics taught at school were lagging a century behind the present state of mathematics. Conferences at Royaumont (1959) and Dubrovnik (1960) set the pace: trying to catch up for the lag of a century, proposing mountains of new subject-matter and translating it into new textbooks, called New Math—a fierce competition between both experts and charlatans with, in general, distressing results. Those who could not catch up were the poor people in the classroom who were expected to teach and to learn New Math, which most often was rather New Nonsense—unteachable, unlearnable, unmathematical.

The euphoria of the 1960s faded away in disillusion during the 1970s. When the movement started, early voices that warned against it got lost in the clamour—pitied as attempts to save outmoded mathematics or attacked as high treason. We are twenty years older now. Are we also twenty years wiser and sadder?

The principal error of the New Math proponents was the wrong perspective: it is an old tradition, this idea that mathematics teaching at any level is determined by what is

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required at the next higher level—a gradual selective process with, at the highest level, noble mathematical research. The fresh idea that New Math proponents added was a short cut: teaching the most advanced concepts as early as in kindergarten—albeit by teachers who had not the slightest idea of what these concepts meant, and were used for, in genuine mathematics. Thus devices serving mathematical abstraction, detached from their mathematical meaning and context, interpreted as subject-matter, and concretized in a preposterous way, were taught to kids of any age.

Opposite to this view of mathematics as a sophisticated subject matter, dropped from above to below, is that of mathematics as a natural and social activity which develops according to the growth and the growing needs of the individual in an expanding world. Mathematics is an attitude, a way to master this world cognitively, practically, emotionally.

Mathematics differs from many other cognitive activities by the way it stresses the relation between form and content. As in any science, the amount of knowledge has enormously increased and is still increasing at an accelerating speed. But in mathematics, the arsenal of means and activities of organizing this knowledge by mathematical means has also increased. Organizing mathematical knowledge by mathematical means has been a concern not of compilators but of productive mathematicians from its early history. The invention of letter algebra and co-ordinate geometry, even of calculus, were primarily ways of reorganizing existing knowledge by creating organizing tools, which eventually proved so powerful that they also produced mountains of new knowledge.

The modern means of organizing mathematics is to identify similar structures hidden in different mathematical objects, operations and methods, to focus on these structures, and to redefine them in an independent way, in order to reorganize and develop broad fields of investigation.

Structures are a universal phenomenon. By structuring the world around us we succeed in mastering it to a certain extent. While counting, measuring, or weighing people, we forget about the individuals; in order to be managed, a rich structure is being impoverished.

Mathematics knows structures of various kinds: the poorest structure imaginable is the particular set, though the system of all sets may be endowed with a rich structure. A wealthy structure is Euclidean geometry, with its lines, planes, circles, squares, spheres, regular bodies, tesselations, reflections, rotations, symmetries. Poor structures are vastly applicable, but applying them means a non-trivial business: enriching the poor structure in an appropriate way. On the other hand, mathematical structures may be so wealthy that they can be applied straight-forwardly, albeit only in quite specific situations.

Modern mathematics teaching is based on an imposing hierarchy. It begins with the poorest mathematical structures, sets, which are gradually enriched by an ever-refined network of branching. In order to construct such a hierarchy, choices have to be made. It is a means to organize mathematics, which, however, can be done in many ways, depending on a variety of objectives.

Piaget, first impressed by Klein's hierarchy of geometry, set out to prove experimentally that this hierarchy was exactly the way space concepts developed psychologically. Then, confronted with Bourbaki's hierarchy of mathematics, he tried the same strategy with regard to the development of mathematical concepts. It was Piaget's general idea that individual development follows epistemic lines, and what should be understood by episteme in geometry and mathematics was identified by him with Klein's and Bourbaki's hierarchies, the only ones he knew. So cognitive development had to start, according to Piaget, with the poorest structures and progress along the road of gradual enrichment. This is, it seems to me, a highly improbable hypothesis. Although Piaget's experiments had been designed to underpin it, the experimental results are not always convincing.

It is a fact that number is learned in the same way as language, as a vocabulary; it is by means of this vocabulary and its regularity, that is by means of the decimal system, that the child learns to master number and arithmetics. However, no hierarchy of mathematics pays any regard to such an anthropomorphic feature of number learning—indeed, mathematics is universal, cosmic as it were. As a consequence, neither Piaget nor his school, nor other psychologists paid any attention to the part played by the decimal structure of number in development and learning.

To give another example, according to Piaget, plane and space are mentally constituted as they are in the systems he knew, that is Cartesian co-ordinates. Notwithstanding this conviction, all observations indicate a polar rather than Cartesian structuring of plane and space in mental development.

The same wrong perspective repeats itself: from poorer to richer structures. This emphasizes the deductive perspective of mathematics as a product, rather than the historical or the developmental perspective of mathematical growth. It is not good didactics. However, justified by Piagetian arguments, it has been accepted in New Math, at least as a principle.

Today's defeatism in some circles is as little justified as the euphoria of the 1960s. The euphoria of the this period came from the erroneous idea that one can change the teaching of mathematics, or of anything else, fundamentally, by decree, by good or bad textbooks or by black-and-white or three-colour prints. This was attempted in many countries, and it is this policy, rather than New Math, that has failed. Unfortunately, the birth of New Math coincided with that of curriculum theories that tried to formalize educational development as a bureaucratic process—a view that is still vigorous and seems to gain strength from every new failure. There exists a different view on innovation, as a learning process involving all people concerned, including the teachers, and that takes places in the classroom.

Today's disillusion is being voiced through the new slogan 'Back to basics', which means returning from New Math to good old math. It looks like ladies' fashions: old style propagated as new look. Can producers so soon adapt educational material? Of course not, they adapt advertising instead. A textbook series recommended ten years ago as the summit of New Math is now being praised as a paragon of good old math. This shows anew how little has changed fundamentally in the overall picture.

'Back to basics' is another wrong perspective. The right way should be forward to basics. But a grandfather clock is not basic, nor is grandfather's arithmetic. Old-time arithmetic problems will never return, old-time teaching arithmetics will never be revived.

But what about old-time numeracy? If this question is being asked, I wonder why people are not as concerned about old-time calligraphy. Medieval manuscripts are things of beauty but old times did not finish at the end of the Middle Ages. Letters and manuscripts of a few generations ago cast serious doubts on calligraphy as a general habit or virtue in former times.

Has numeracy declined as a general ability? I am not sure. Is it declining now? Perhaps it is in some countries. It would be a task for educationalists to find out how much educational measurement contributed to this decline. In some parts of the world, educational theory and practice are haunted by the idea that in education things can and should be measured. Even if this were true, it would not answer the question: 'Which things?' You need a philosophy of teaching to know which ones. If it is the wrong things that are being measured, the conclusions may be formally right, but meaningless or dangerous.

Let us review the wrong perspectives I

signalled. They are all related: a downward progression to lower from higher mathematics, poor structures preceding rich structures, innovation by external pressure rather than by internal growth, back rather than forward to basics. Basics should mean a basic philosophy, educational in general, and specific to a particular area. There is no education and no educational development without a philosophy, and catalogues of goals and objectives cannot be a substitute for a philosophy.

Mathematics is both a natural and social activity of man, as are speech, drawing and writing. Mathematics is among the first cognitive activities we know about and mathematics teaching was the first kind of teaching. But mathematics has grown and changed, as has mathematics teaching and its philosophy, under the influence of social change. Let me show it by the example of numeracy.

Already millennia ago a certain degree of numeracy was required from anybody who took a part in the economic life, but this minimum was soon far exceeded by the clerks of public and private bureaucracy and enterprise, which became one of the sources of professional mathematics.

There are degrees of numeracy—as there are of literacy: what shop-keepers and bankers asked from their employees was an extremely high level, attained only by a minority, who earned their lives as reliable performers of arithmetical operations—a cheap labour force, which, for about half a century, succeeded in stemming the propagation and development of mechanical and electrical calculators.

Human numeracy, even at the highest level, can no longer compete with that of electronic computers.

What does numeracy mean? Whatever the answer might be, it meant different things half a century ago from what it means now, and different things in developing than in developed countries; beyond numeracy, the same statement holds for all of mathematics. Mathematics as an idea is universal, but as a phenomenon it depends on environment. I know little, if anything, of the Third World and its needs, but every time I see mathematics for children in developing countries merely copied from that taught in the developed areas, I felt shocked, as I feel shocked when I see mathematics for youngsters derived from Bourbaki's.

It is a fact that at the age of 12–13, the majority of youth are not yet able to do reliable arithmetic. It is an illusion to believe that improved teaching could bring about major changes. It would be lost labour to try it. Today, arithmetic to be relied upon is the work of computers. Understanding arithmetic is another thing. It is deplorable that in most educational research on mathematics these two things are not being properly distinguished: automatized skills, and understanding. Taxonomies pretending to clear up foggy ideas on comprehension levels have spread even more fog and confusion, in particular in test development.

If it is a fact that few among the 12–13-year-olds are capable of reliable arithmetic, there are many more who are able to understand arithmetic. Failing on skill tests does not prove failing understanding. Fortunately as a counterweight to the test culture, textbooks are increasingly concerned with teaching arithmetical understanding. New methods have been developed to teach algorithms through sound comprehension of the positional system.

Our positional system is built upon two principles, a structural one, condensing ten units into a new unit, and a notational one, using the same symbols for numbers of units of any level, while distinguishing unit levels by position.

The first principle goes as far back as old Egyptian arithmetics, while the second arose in Babylonian arithmetics (though with 60 rather than 10 as a basis). Both of them have been concretized by modern material (Fig. 1(a)): cubes for the lowest units, combined into rods of 10, combined into plates of 10 rods, combined

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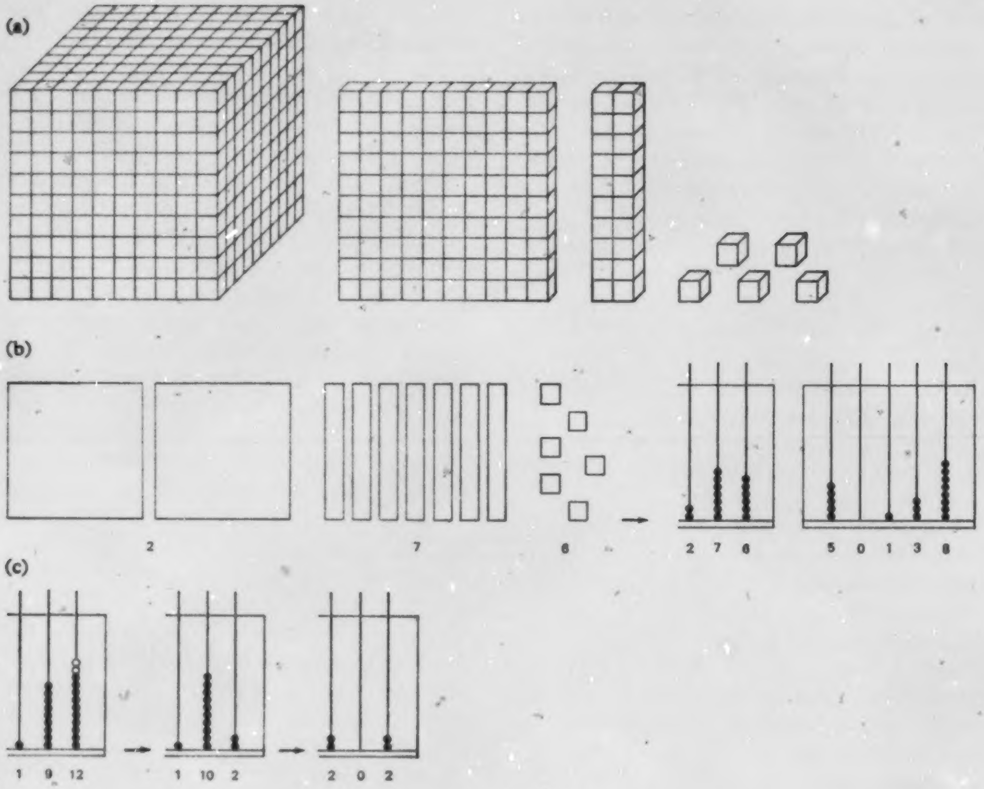


FIG. 1.

into large cubes of 10 plates, representing the units 1, 10, 100, 1,000, respectively—with other bases than 10, the system is available as 'multi-based blocks'. It is valuable material, though it lacks flexibility and the complete positional idea. Both principles are united in the abacus, the oldest arithmetical tool of mankind, preserved in parts of the Soviet Union and in Eastern Asia, neglected in Europe after the rise of written arithmetic, but now revived as a highly effective didactic tool (Figs. 1(b) and (c)).

I chose numeracy to exemplify the impact of philosophy of education on development of education. Numeracy, however, does not exhaust mathematics, even at the primary level. On the contrary, overstressing numeracy may be a symptom of bad philosophy—or let us say, bygone philosophy which, however, is still adhered to by the great majority of textbooks at the primary level, notwithstanding lip-service paid to other values.

On the other hand in spite of textbooks the world-wide attempts to express a broader philosophy by a new kind of mathematical education have been numerous and promising. The reader will forgive me if I restrict my report to the philosophy with which I am most familiar, that of the Instituut Ontwikkeling Wiskunde Onderwijs (Institute for the Development of Mathematics Education (IOWO)), Tiberdreef 4, Utrecht, Netherlands. IOWO was institutionalised in 1971 after a ten-year period as the Commission on Modernizing the Mathematics Curriculum. Let me summarize IOWO's fundamental ideas in a few slogans, stressing:

Mathematics as a human activity rather than mathematics as a ready-made subject-matter.
Mathematizing rather than mathematized.
Reinvention rather than transfer of ideas.
Reality as an *a priori* source rather than a domain of application of mathematics.
Relationships rather than isolated phenomena.
Rich contexts rather than collections of word problems.
Constitution of mental objects rather than attainment of concepts.
Multiple approaches to new concepts rather than multiple embodiment.
Understanding rather than skill.

I said 'stressing', which means a shift of balance. Institutionalized learning tends to put the weight on the 'wrong' side, innovative efforts tend at adjusting.

A good philosophy expresses itself by deeds rather than by words. Slogans do not mean anything unless they refer to facts. Mathematical education includes a large amount of material, not only for the pupil, but also for the teacher, the teacher student, the teacher trainer, the counsellor, the education developer; accounts and analysis of teaching experiences on all levels, successes and failures, tested and untested ideas. Yet all this material is not worth anything unless its philosophy can be implemented.

On a small scale, it has been proved it can. On the large scale, the proof will be a matter of time. Innovative education is a learning process of the society, but compared with individual learners, learning groups, developing institutions, society is the slowest learner of all, and there is easier subject-matter to be learned than mathematics and teaching mathematics.

The present article has not been written to implement ideas on teaching mathematics, but I shall at least try to give you a faint idea about what my 'slogans' intend to mean.

Let me start with a little story from kindergarten: There is a fish tank in the classroom. From time to time it must be cleaned. The children wonder how the teacher does the cleaning. The fish must be caught with a dip-net and put into another vessel. 'Now we can easily count the fish', says Ann. She has tried it once, indeed, but did not succeed. 'Miss, they are swimming criss-cross in a crowd', she had said.

One by one the teacher scoops out the fish. Three have been counted but then three more are caught together. 'Miss, now again I cannot count them', Ann says. Miss answers: 'Perhaps you can draw the fish and if you have drawn them, count them on the paper.' It is a good idea. Ann fetches a piece of paper and a pencil. 'You should wait a moment.' She first draws the three fish in the other vessel, and then the three new ones. She can easily keep pace, no fish is skipped. When the tank is empty, she is going to count the fish. Proudly she exclaims: 'Now I know how many there are: fifteen.'

A few days later two fish are dead. 'It is a pity, it is wrong now', she says. She does not know how many living fish are now in the tank. 'Take your drawing of the fish', the teacher suggests. She crosses out two fishes and now knows the new answer.

I do not need to comment on this little story. Another is, for instance, 'Waterland', a fairy island on which the first-graders spend a few months of mathematical education. They arrive by boat (Fig. 2).

How many children, how many buses with two or three on a bench? Which way do they drive? What is the shortest way, and how to describe it? How long is this road? How do you go from the windmill to the lighthouse? Guess the inscriptions on that signpost. Where can

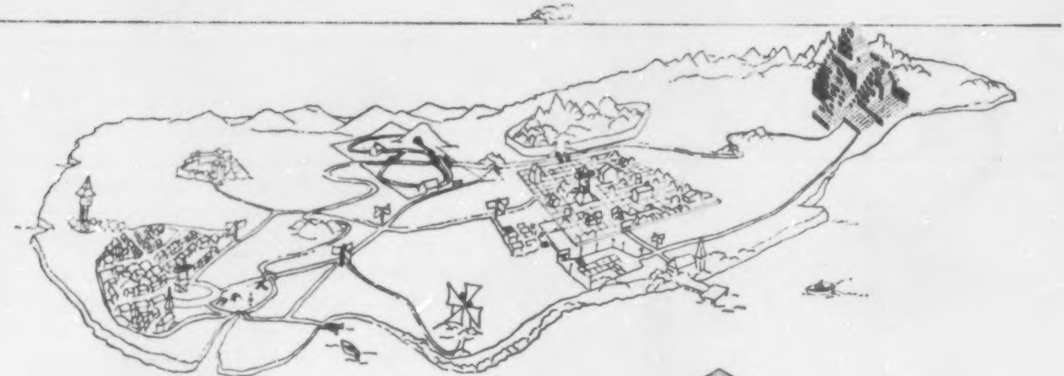
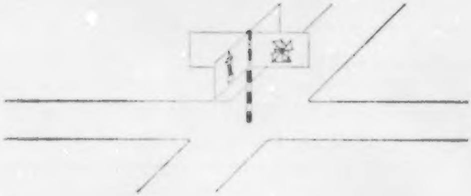


FIG. 2.



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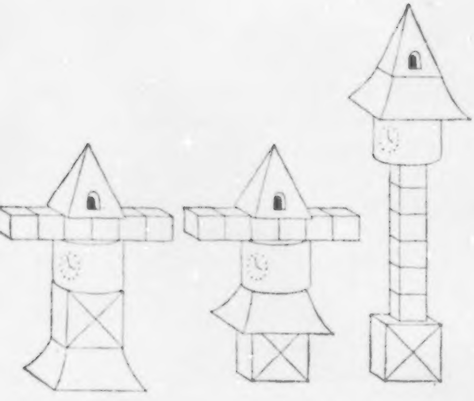

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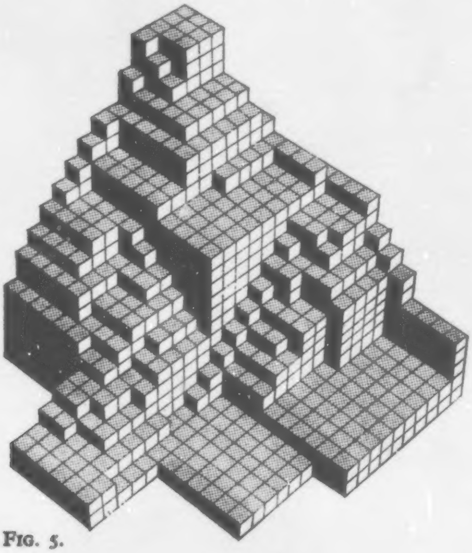
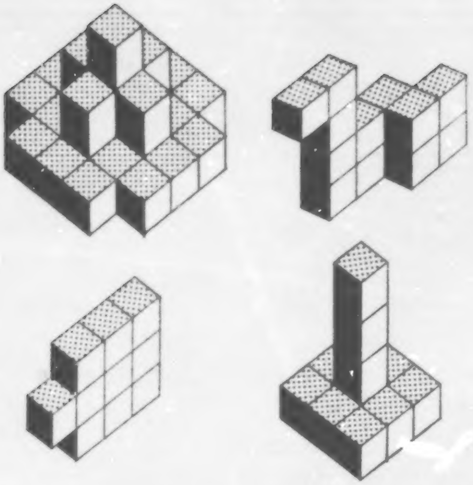


FIG. 5.

this signpost stand? (Fig. 3). The towers on the island are built from the same pieces, how can you describe them? (Fig. 4).

How can you climb the mountain of blocks in the right corner? (Fig. 5). How many blocks does it consist of? How can you describe block structures? (Fig. 6). What do you see from that point of the island, and where has this picture been taken? (Fig. 7). How many cars on that parking lot? Buslines with people getting in and out—a way to do arithmetic (Fig. 8).



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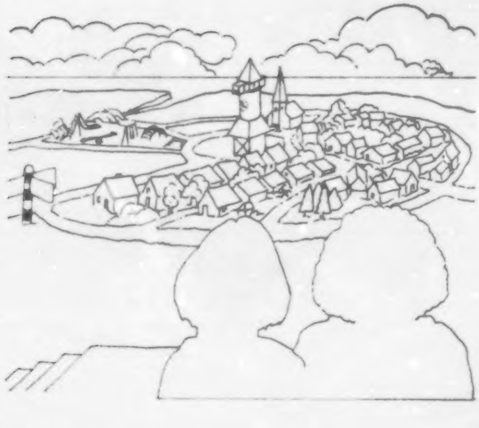


FIG. 7.

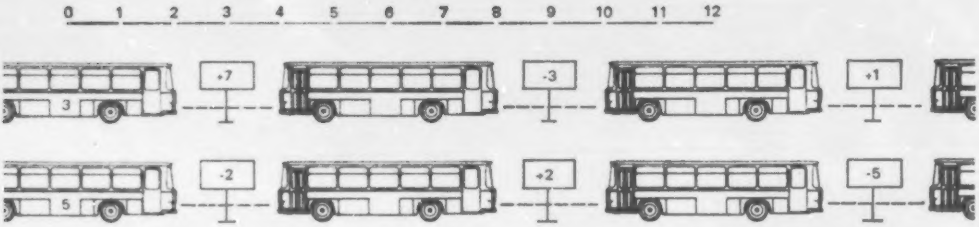
In the various conceptions of New Math, 'sets' is a basic concept. I need not stress that IOWO can dispense with such premature abstractions. Number is not based on nor introduced by sets. A few examples to show how number is acquired by and founded on structuring are provided by the pictures. How many handkerchiefs? How many pegs?—Can it be done with fewer pegs? (Fig. 9). Are there more moons than suns (Fig. 10), more black than white pearls (Fig. 11), or how do you know that the numbers are equal?

Waterland is the kind of context that in IOWO terminology is called a 'location'. Another kind is the 'story'. As an example I take that of the rescue of the *Bermuda*, a yacht in danger, identified and rescued by a tug boat (lesson for pupils of grade 4–5). It is an opportunity to learn to use maps and to do geometry. I can give you one example from this story: In which order were the pictures taken from the ship sailing along the coast? (Fig. 12).

Ratio is one of the most powerful means to structure reality. In teaching mathematics its power is strongly being reduced by premature mathematizing and formalizing. The IOWO approach is shown by a piece of a lesson (grade 1–2) (Figs. 13 and 14).

Let us finish here. Rather than a global view I have disclosed a few examples in order to illustrate IOWO's fundamental ideas.

IOWO's curriculum has been written in Dutch; some pieces have been translated into English or French. An overview in English has appeared as 'Five Years IOWO', in *Educational Studies in Mathematics*, Vol. 7, No. 3, August 1976.



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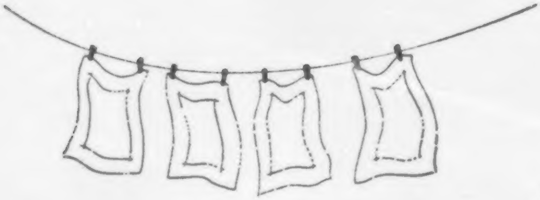

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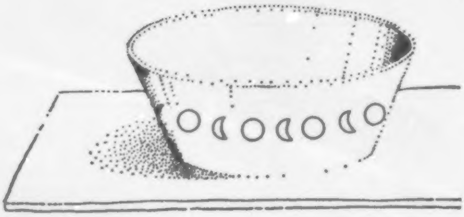

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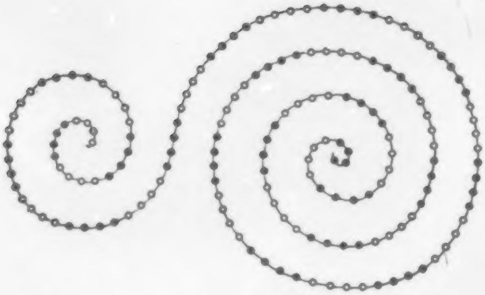

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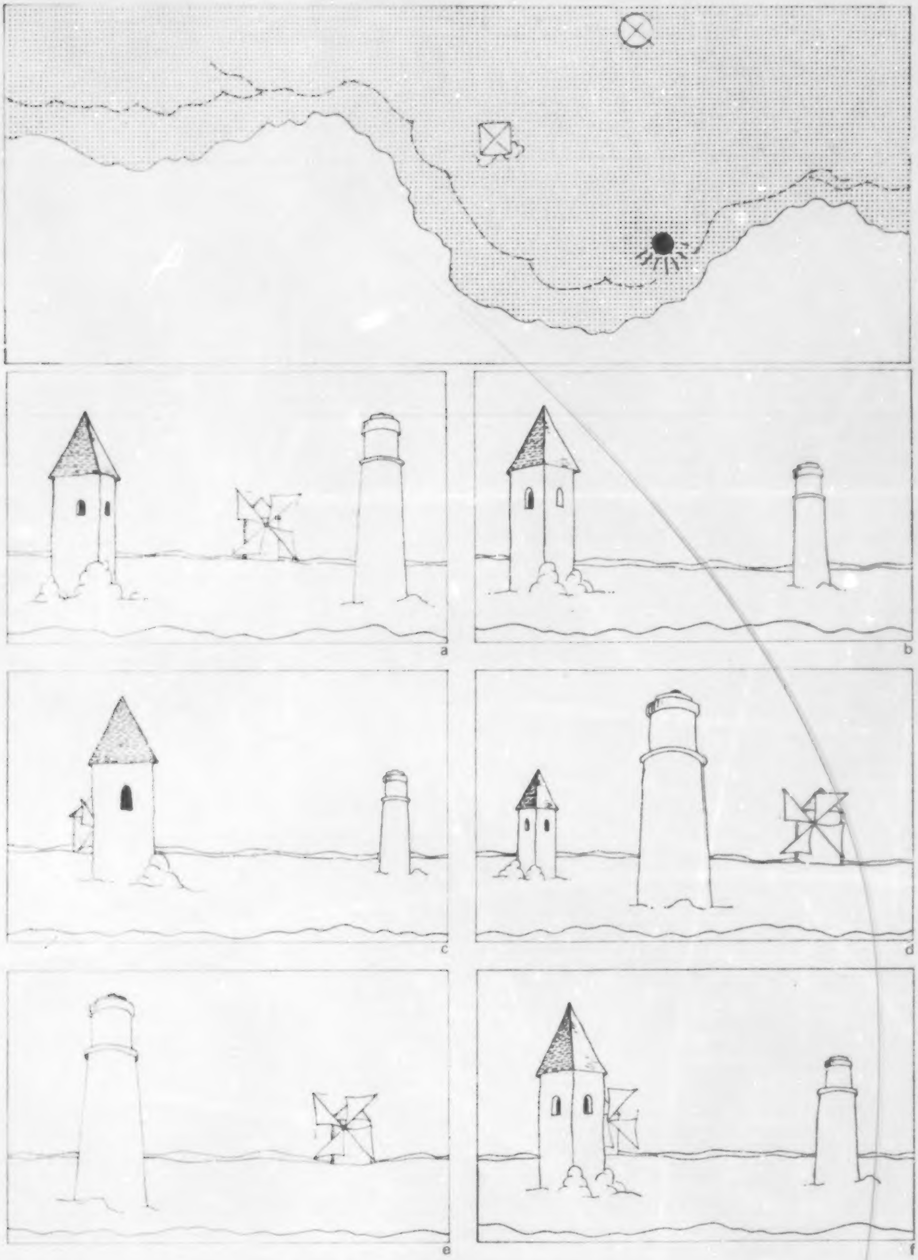

Fig. 12.

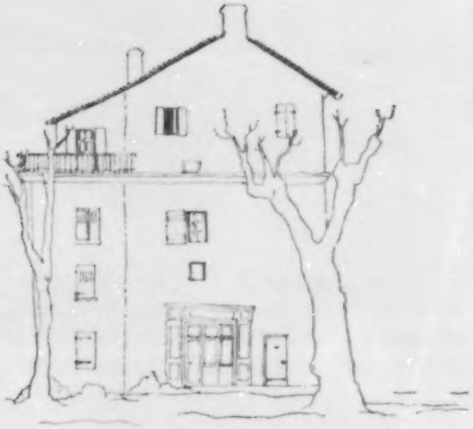

FIG. 13. 'How tall do you think you would be on this picture?' Charles points out what his estimate is. 'All agreed?'
John thinks Peter would be rather tall: 'You aren't as tall as that door.'
Charles corrects his estimate.
The teacher adds another part of the picture.

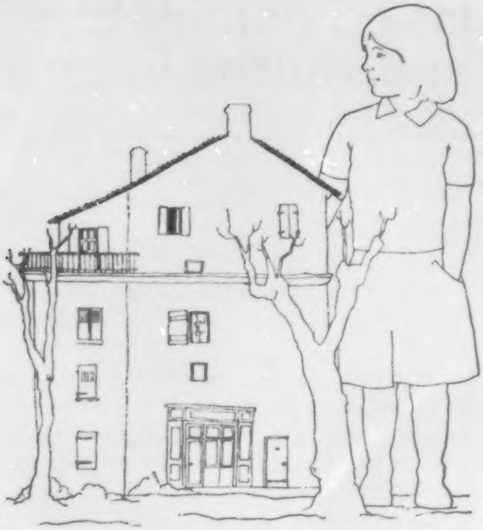

FIG. 14. 'How is that possible?'
'Oh, I see, it is a doll's house!'

Rolf Hedrén

Hand calculators and maths in primary school

In Sweden, as in other countries, particularly developed ones, the hand-held calculator has become cheaper and more common in society. This development has of course affected secondary education in mathematics. The hand-held calculator has already replaced the slide-rule as the predominant calculating aid in years 7–12. The predominant question is how best to use the possibilities of different types of calculators (from simple types for the four rules of arithmetic to programmable ones).

Other and maybe still more difficult questions are: whether the calculator be used in primary school, and if so, how; what consequences will use of the calculator at primary level have on the students' skill and knowledge?

In Sweden the Board of Education has set up a committee to analyse the consequences of the hand-held calculator both in the compulsory school (forms 1–9) and in the upper secondary school (forms 10–12). This committee has been split up in smaller teams working with different stages. As chairman of the team dealing with this question in upper primary school (forms 4–6), I shall discuss mainly this level. Our aim is not only to let the students use the calculator from time to time as a stimulating interruption of regular mathematics instruction. We want to examine how the calculator can be used consistently and favourably in education and what possible risks might be involved.

Problems

The easiest and perhaps least dangerous position towards calculators is presumably to prohibit them altogether. There is no lack of arguments in favour of this attitude. Students should learn mental arithmetic and paper-and-pencil algorithms, otherwise they will not be able to perform these operations without a calculator.

However, in trying to penetrate a little further into the problems, we have come to a different conclusion.

The hand-held calculator is becoming a basic element in society and at home and is used daily by more and more people. If this development continues—and everything today indicates that it will—the students of today, the citizens of tomorrow, will in all probability have very little use for paper-and-pencil algorithms. Teaching these algorithms takes up about 50 per cent of the time available for mathematics teaching. Is it really sensible to spend so much time, work and money on a matter which the students will probably use very seldom in their lives as adults?

Rolf Hedrén (Sweden). Lecturer in mathematics at the college at Falun-Borlänge, and chairman of a committee dealing with the consequences of the hand calculator in the upper primary school.

There is also a growing trend to bring school education closer to the life of society. There again, why should calculators be forbidden in school when they are used in everyday life?

We know from research in our country that students' mastery of relatively easy algorithmic exercises is poor in a traditional teaching context. It is reasonable to assume that the difficulties encountered in mastering these exercises might contribute a great deal to the diminishing interest in mathematics on the part of most children during compulsory schooling.

At the present time, students' ability to solve mathematical problems—that is to make the correct type of calculation in the correct context and in the correct order—is also unsatisfactory. Perhaps this ability could be taught more easily if the troublesome manual calculations that the students obviously are not mastering, were eliminated. If the students are allowed to use handheld calculators, could they perhaps learn problem-solving faster and more easily? In such a case the teachers could give students problems directly taken from situations rather than 'doctoring up' the numbers involved to facilitate calculation.

Nevertheless, we are of course aware of the fact that the introduction of hand calculators into the school system must be accompanied by other changes.

First of all, new types of textbooks must be used, textbooks that do not contain so many paper-and-pencil algorithms, because students can learn to use the calculator for the four rules of arithmetic very rapidly. Textbooks should contain lots of problems drawn from reality. Additional mathematical concepts not now in the curriculum might be added: for example, one might teach at a much earlier stage how an error in rounding-off is transmitted through a more extensive calculation.

Even if we consider the exercise of algorithms rather meaningless in itself, the learning and carrying out of them may have many positive side effects which would thus disappear. For example, with the algorithms the students exercise mental arithmetic and estimations (specially in connection with division) and get an idea of the divisibility properties of numbers, prime numbers, and the order of magnitude of numbers (which is the greater of two given numbers?).

Proposals for action

My team has worked out a set of proposals for action which can be summed up as follows:

Increased repetition and exercise of table skill up to 9+9, 18—9, 9×9 and 81 : 9.

Increased training of mental arithmetic: to this section we relate exercises in 'applied table skill', i.e. exercises of the following types: 600+700, 4,070+300, 1,300—600, 2,100—1, 20×300, 6×610, 900 : 30 and also 7×8+5. Short cuts in mental arithmetic ought to be stressed more than is done today.

Increased training in estimations: the students should round off the given numbers and afterwards make calculations of the type which was mentioned under the previous point.

We need to emphasize these points in order to counteract the possible decrease in capacity for mental arithmetic and estimations when there is less exercise in algorithms.

For pencil-and-paper algorithms we have stated certain specific goals which should be reached by virtually all students by the time they have finished upper primary school.

Students should be able to add and subtract with two terms, integers as well as decimal numbers.

Students should be able to carry out multiplication and division calculations where at least one of the factors is a digit or a product of a digit, and 10, 100, 1,000, etc., integers as well as decimal numbers.

What I have mentioned here is to be regarded as minimal. The more able students will certainly master more intricate algorithms.

Decimal numbers will be introduced early because most problems in real life deal with prices, lengths, etc., which are most easily and comfortably treated with decimal numbers.

There should be an increase in word problems to be solved with hand-held calculators.

It is important that not all problems in one section use the same rule of arithmetic. There should be problems where more than one rule is to be used. This latter type is generally rather difficult, as most simple calculators do not follow current rules of priority. We think, however, that real-life problems arranged in the way mentioned will give the students exercise in using their mathematical skill to solve problems from everyday life which they will encounter as adults.

The students must be trained to estimate results of word problems. This is important as they can easily press the wrong button, use the wrong rule of arithmetic, or make similar mistakes.

In a revised curriculum, students would learn to solve certain problems by collecting and putting together relevant data, judging what calculations ought to be made and carrying them out, with a hand-held calculator if they wish. The aim of the projects is of course to train the students to use mathematics in a practical situation. As an example of a project I might mention: 'How much will a class party cost?'

Free discovery, i.e. tricks and strategies with and without a hand-held calculator, should be an important part of a curriculum.

Through games, competition and experiment with mathematical content, the students get an opportunity to develop their creativity and become familiar with numbers. These exercises might give the students an opportunity to ponder upon questions of prime numbers, the number of factors of a given number, perfect numbers, etc.

An example of an exercise of free discovery is given here. One writes the following multiplications on the blackboard:

$37 \times 3 =$ $\quad$ $37 \times 9 =$
$37 \times 6 =$ $\quad$ $37 \times 12 =$

One lets the students make calculations with their calculators. One then writes the following multiplications on the blackboard and asks the students to guess the answers and then to check the results with the calculators:

$37 \times 15 =$ $\quad$ $37 \times 24 =$
$37 \times 18 =$ $\quad$ $37 \times 37 =$
$37 \times 21 =$

We want to examine what possibilities exist to increase children's comprehension of mathematical concepts with the help of hand calculators. For example we can let students use their calculators to multiply two decimal numbers or an integer and a decimal number and find out how many decimals there are in the product. In that way they can 'discover' the rule for the placing of the decimal point in a multiplication.

When calculating with powers, the hand calculator is an excellent tool for teaching the value of the power. At the same time the students may understand how fast a power grows and in this way unconsciously get an introduction to the exponential and power functions.

Experimental work

Curriculum material for form 4 along the lines described above has been prepared by the working group and is being tested this year in eight classes. On the basis of this experience, including the criticism and suggestions from students and teachers, we are now revising the material and will test it in additional classes during the next school year. Materials are being tested in a similar fashion throughout the upper primary school.

We are observing and recording the testing by recording lessons on tape-recorders and examining them closely; we are also carrying out direct classroom observation, inquiries and interviews with teachers and students. Some control classes are also investigated in the same way. Through this programme we want to learn how teachers and students handle the hand-held calculators, and what use calculators are in different contexts. We thus hope to discover possible inadequate methods and recommend better techniques. On the other hand we hope to be able to detect the possible side-effects that calculation with algorithms has and try to discover whether or not we can compensate for the lack of skill which will thus arise when exercise with algorithms is reduced. If we see that the students of the experimental classes in any respect are less well prepared we will have to try to find ways to compensate for this lack.

We will also administer traditional tests in both the experimental and the control classes. We will try to examine not only the skill in calculation with algorithms but also skills that are not directly related to algorithms, such as the solution of word problems, ordering of numbers by magnitude, the use of adequate units, estimating proportionality, interpreting diagrams, etc.

It might be mentioned that a special working team has compiled a test of the non-algorithmic basic skills mentioned above to be used in forms 6 and 8. This has already been tested in a lot of classes that have not used hand-held calculators. It will of course be used when our experimental classes reach form 6. But it is also expected that the test will have a much wider field of application. Irrespective of the experiment my team is carrying out, we are convinced that the hand-held calculator in one way or another will find its way into the classroom. It will thus be extremely valuable to be able to compare the skill and knowledge of the students of to-morrow with those of students who have not had access to a calculator.

Lessons

Of course we have not yet been able to evaluate the experiment, but our experiences so far are very positive. The students have been interested in the work with the hand-held calculators, and seem especially to appreciate the free work to which the projects give rise. The teachers' opinion is that the students learn at least as much mathematics as with traditional methods.

In some places there have, however, been complaints from parents who fear that as a result of the experiment the students will learn less than with traditional instruction. After a thorough discussion with the parents and after giving them some direct experience with the experimental programme, this concern has been largely overcome.

Another problem is difficulty on the part of both students and teachers in handling calculators. Though we use only the simplest types, such functions as the repeat function and the memory might cause considerable difficulties. We have realized that in the revised edition of the material we must explain much more thoroughly how different calculators function. Of course there will also be a need for in-service courses for teachers in use of the calculator.

We feel that the results we have obtained so far clearly indicate that hand-held calculators can be and will be introduced in schools as early as in upper primary school—and perhaps earlier—if there exist specially adapted textbooks and there is an awareness of the dangers that might be involved.

Zbigniew Semadeni

Mass media in the mathematical training of Polish primary teachers[*]

I shall speak of teachers in lower primary grades, in charge of not only mathematics but also of reading and writing, elementary science, crafts, music, plastic arts and physical education; in Poland, they teach children of grades 1–3 (age from 6 or 7 to some 10 or 11).

The popular opinion is that teaching in lower primary grades requires less qualified people. In some sense this is true; however, if there is to be really good instruction, primary teachers should have sound knowledge of the subject, different from, but not inferior to, that needed for secondary schools.

The social status and self-esteem of primary teachers in Poland used to be below that of secondary-school teachers, but the situation is now changing. According to present national policy, primary teachers should—in principle—have university education. Though it is still a goal rather than reality, there is a huge programme of in-service and pre-service training. In 1977 most Polish universities started master's-degree programmes for prospective kindergarten and primary teachers.

In the present curriculum, prospective primary teachers have 120 class hours (45 minutes each) for mathematics (30 hours for lecture, 45 for laboratory exercises and 45 for desk-and-blackboard exercises) augmented with a comprehensive method-oriented course (all subjects together); prospective kindergarten teacher have 75 class hours for mathematics.

What mathematics for primary teachers?

Although there is continuing debate on the subject, most educationists believe that in lower grades mathematics should be taught by a generalist teacher rather than by a teacher-mathematician. In particular, the concrete thinking of a teacher-generalist is closer to that of a child, and this may be more important than knowledge of a more abstract approach. Still there is a problem in that typical teachers in lower grades are rather poor in mathematics and lack confidence in their ability to learn the subject.

In mathematics curricula for primary teachers, current thinking holds that the subject must be studied in some special order: first, logic,

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then sets, then natural numbers, etc. I am against such an emphasis because the order of deductive theories does not reflect the order in which children learn mathematics. Elementary teachers do not need mathematical presentation of definitions, theorems, proofs, which are hard to learn and do not give them hints of how to use this knowledge in the classroom.

Half a century ago, many European universities offered courses of 'elementary mathematics from a higher point of view' (e.g. how to construct fractions assuming natural numbers to be known). In my opinion, nowadays this attitude does more harm than good, particularly in primary grades. The teachers rarely understand it well. Still worse, this kind of theoretical arithmetic often conveys misconceptions of how to teach children. In teachers' education, mathematical concepts should be presented in a way which is both correct and relevant to the thinking of the child; correct in substance, but without formalism.

We should bear in mind that the teachers will probably teach the way they have learnt a subject. Therefore, it is very important that the learning of student-teachers be organized with this in mind. They should carry out those activities devised for children which are new for them, at adult pace, of course, and with didactics in mind. Such an approach is the one most likely to guarantee an understanding of mathematical concepts by teachers and is a good starting-point for learning and appreciating more sophisticated teaching methods. General statements should be based on previous exploration of concrete situations. Thus, laboratory or workshop sessions with short intervals of explanations addressed to all students seem preferable to lectures, which should follow the practical activities. This is a departure from a traditional university model, where mathematical lectures were intended for general theorems to be applied afterwards in the form of exercises.

Prospective teachers have often not acquired in youth the necessary experience to understand certain mathematical relations and rules. The best method is to give such a person the opportunity of carrying out tasks similar to those which should have been performed in childhood. This gives better results than simply explaining these notions by means of words and symbols. Obviously, the version provided for an adult should not be a repetition of that intended for a child: one must take into account concepts already mastered, as well as the different pace and different motivation of an adult. Adults seem able to grasp the new concepts involved in modern mathematics if they first solve a number of exercises based on concrete examples.

It is very difficult to find enough people capable of teaching integrated courses of mathematics and didactics. A more realistic approach consists of separating this into a content course in methods of instruction which includes practical school experience. The objective of the former course (taught by a mathematically competent person, not necessarily one familiar with teaching children) is to show the teachers how to do child's mathematics, in particular, how to solve certain problems by concrete manipulations followed by some reasoning, whereas the objective of the latter (taught by an educationist) is to show how to help children learn mathematics.

Curriculum reform and teacher training

In Poland, the outline of a new mathematics curriculum for grades 1–3 in primary schools was published in 1971 and was put into practice throughout the country in 1975. It changed the goals, content and methods of instruction. The vast preparation included: writing textbooks, devising apparatus, preparing the teachers. While the first two were serious tasks but relatively easy to carry out, preparing teachers posed a great problem. Very few people were sufficiently familiar with the new curriculum to teach teachers; on the other hand, the number of elementary teachers in Poland totals some 70,000 and therefore it would have been impossible to re-train by traditional means. Moreover, many teachers were not adequately prepared for the traditional curriculum either. Preparing teachers meant not only helping them to master the new content and methods, but also changing their attitude toward the child's learning.

Each country attempting to carry out a basic teaching reform faces similar problems. The best prepared syllabuses will fail if the teachers are inadequately prepared.

In Poland, the only possible solution was to make use of the existing Radio-TV Teachers' University (NURT). It was to include the Studium of Primary Teaching Mathematics (partly autonomous and organized differently from other parts of NURT).

The main activities of the studium started in January 1975 and terminated in June 1977. Their objectives were both immediate and long-term ones. The immediate aim was to prepare the teachers for the reform. The main stress was put on involving all teachers who were to teach mathematics in grades 1–3. It was hoped that the largest possible number of them would participate in the activities of the studium. Attempts were made to minimize the percentage of teachers who could not participate for objective reasons (too many domestic obligations, poor health, etc.) or subjective ones (e.g. fear that the new, abstract mathematics might prove too difficult to learn), to avoid jeopardizing the reform. The long-term aims were to ensure a sound basis for continuous education of teachers, revealing to them possibilities which still occur in primary mathematics teaching, and encouraging them to carry out further studies and to seek their own solutions.

The achievement of these goals required the development of a system of distance teaching that could reasonably guarantee the essential minimum of preparation for the largest possible number of elementary teachers and at the same time provide teachers with the opportunity of extending the scope of their knowledge beyond the minimum, given the time and inclination. Moreover, the system meant to avoid sophisticated means and to be feasible with the existing constraints of staff and resources.

The structure of the studium

The organizational system of the studium was divided into three categories: (a) central (Teachers' Training Institute; 3–4 people employed for this purpose); (b) regional (19 branches of the Teachers' Training Institute; 1–2 people dealing with primary mathematics teaching in each of them); (c) local (some 600 studium inspectors, usually representatives of a school superintendent's office, sometimes teachers, each paid separately for the services for the studium).

The studium carried out the following activities: television lectures; radio programmes, publishing materials as supplements to a teachers' bi-weekly *Oświata i Wychowanie*; homework published in the same supplements; and consultations and examinations.

Television and radio programmes were transmitted through main Polish channels and partly performed the role of an open university for large sections of society, in particular for parents. The other forms were for the registered studium listeners only.

The homework and exams were the only forms of the listeners' activities under control. Listening to television lectures, radio programmes and the reading was not verified.

The material contained in the homework tasks conformed to the minimum essential knowledge required for teaching the new syllabuses, whereas on television and the radio and in the bulletin, there was a lot of additional material on the primary mathematics teaching and related questions.

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Preliminary organizing work

The basic preparation took about two years. The major tasks were working out the organizational principles of the studium and its programme and the preparation of studium inspectors and people in regional branches of the Teachers' Training Institute. In 1973–75, various summer courses and all-year courses were held. A typical course lasted five to six weeks and was intensive training in primary mathematics teaching, sanctioned by an examination. Preparation of local staff was a necessary pre-condition for the whole project.

In Autumn 1974, the studium's listeners were registered at the appropriate branches of the Teachers' Training Institute and by the studium inspectors; registration continued during 1975. The first examination was held in October 1975.

The total of registered listeners was about 65,000 (almost all of them women).

Television lectures

The studium was allotted about thirty half-hour lectures a year. They were transmitted once a week around 4 p.m. on Channel 1 and repeated another night (after 10 p.m.) on Channel 2 (which does not cover the entire country). Almost all the listeners complained about the timing (in the afternoon many of them were having lessons at school or were on their way home), but more suitable hours were not available. Lectures were video-recorded at branches of the Teachers' Training Institute to be available on request.

The 92 lectures delivered in 1975–77 can be divided into the following groups: the principles of the reform (3 lectures at the beginning and 2 at the end), the development of mathematical notions in children from a psychological point of view (3 lectures), sets (7 introductory lectures without symbols and 4 more advanced ones), the notion of a number, addition and subtraction, equations, word problems, various abaci (17 lectures), space orientation exercises and an introduction to geometry (5), multiplication, division with remainder, divisibility (10), square roots, arithmetical and geometrical exercises (6), non-decimal systems and powers (9), fractions (7), child's geometrical activities (6), negative numbers (2), co-ordinate system, scale and plane (3), discussion on the curricula for grades 1, 2 and 3 (6 lectures), discussion on examination papers (2 lectures, each presented three days after the examination had been taken).

In our television lectures we wanted, first of all, to provide our viewers with what the printed material cannot give, that is, motion. Films presenting fragments of lessons devoted to new subjects and new teaching methods were shown during most of the lectures. In fact, some of the lectures were merely films with commentaries. The remaining television lectures were allotted to such activities as manipulatory exercises (e.g. handling logical blocks), drawing diagrams, or explaining some theoretical problems.

Films

Films shown on television were made in classrooms of various schools. The lecturer first conceived some fragments of lessons which would be good samples of methods of instruction (for the given topic) and looked for a teacher who would agree to prepare the lesson and carry it out with her (or his) pupils. Thus, it was neither a routine lesson in the given school nor a part of an experiment: it was prepared just for television. It was an illustration of some didactic ideas and an example of recommended or reasonable behaviour or action of the teacher rather than a concrete case of how children learn.

Our policy was that the children should not be selected but the teacher should be one of best available. Children's mistakes were welcome if they were typical of their thinking (rather than a result of, say, inadvertence); yet, didactic errors on the part of the teacher could not be shown on public television (leaving them without comment might be confusing; criticizing them would deeply hurt the teachers' feelings). Occasionally, when we wanted to criticize a typical wrong teacher's mistaken behaviour, we tape-recorded a simulated scene and (in order to avoid identification) presented it later on television with children's drawings instead of photographic pictures.

We bore in mind that we should refrain from showing activities difficult to carry out in the ordinary classroom (e.g. those which require sophisticated apparatus or laborious preparations on the part of the teacher).

As a rule, children were not prepared in advance and not aware of what would be the topic when the television people came. However, if either the scope or the timing of the lesson did not fit what the children were originally planned to do, we agreed that the teacher would go through some prerequisite material to fill a gap in their knowledge. Sometimes (rarely) the teacher tried the lesson out with different children so that she could make any needed adjustments. For the given children the lesson was always new.

When the teacher was ready, a television team (four to six people) came to the school to film the lesson. Only one camera was used at a time. Because of technical problems (lights, microphones, close-up of child's work, repetitions if something significant was not seen or heard, etc.), it was hardly possible to shoot the lesson without several interruptions, which were particularly disturbing when they interfered with children's responses. Usually, it took one or two hours to shoot a meaningful fragment of a lesson. Children were sometimes very tired. Lecturers always watched the lesson, ready to discuss it during breaks. Sometimes they interrupted the lesson when they noticed a teacher's error which could not be cut out during editing.

Television staff did the film editing. Lecturers were present during most of this process, suggesting what is important and what to cut off. The guiding idea was that the film be short and comprehensible to teachers watching it. Thus, we tried to delete or shorten material less interesting for teachers: dull parts of the lesson, repetitions, diversions by the teacher of the children, etc. As a result of several hours of editing, an average of about one-third of the original film was shown on television as a five- or ten-minute film. This enabled us to present up to five different teachers in one half-hour lecture.

However, cutting off those pieces where nothing educationally significant was seen had the effect of speeding up the pace of the lesson: children looked brighter than they really were. This was one of the reasons that many teachers did not believe that they were watching ordinary children, not prepared beforehand. Teachers were more convinced when their colleagues organized analogous activities in the classroom and found them feasible.

Radio programmes

Initially it seemed to us that because of the nature of mathematics teaching, radio would be of little use; and it could only help to reduce those parts of television programmes which were mere talking. Each year we got eight twenty-minute broadcasts (at 8 p.m. and repeated at 6 a.m.). It turned out, however, that radio was very useful for two types of programmes: (a) answers to questions raised by the listeners (contained in letters, posed during meetings, or informally)—unfortunately, most questions concerned organizational matters rather than subject-matter; (b) discussions on some controversial didactic problems, such as computation skills in the new curriculum.

After a few months we realized that the radio programmes aroused the interest of parents who

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had heard the programme by chance. Therefore, we later chose topics which could be of interest to the majority of the population and could popularize the idea of the reform of primary mathematics teaching, leaving more technical matters for the forthcoming extended printed version of the broadcast.

Published materials

Published materials appeared about twenty times a year (sixteen to forty pages each time) and were mostly modified versions of television lectures. The printed texts included a more extensive exposition of the subject discussed on television; they often included detailed descriptions of fragments of lessons presented as films. A variety of other materials were also published, in particular detailed discussions on homework tasks (after they had no longer been accepted for credits) and on examination tasks.

Homework

The individual work was regarded as the most significant part of the studium. The main problem lay in devising a substitute for the laboratory approach. We understood that mathematical activities of elementary teachers should begin with exercises related to those suitable for children. This, in turn, should be a basis for abstract concepts, symbolic representation, and didactical discussions. In such a way, we wanted to provide the teacher with a variety of concrete examples which—after certain modifications—could later be used at school. We were convinced that this way would give stronger motivation for studying the subject and better results. We needed to work out a scheme practicable in case of distance teaching, when often there is no one to help the teacher except colleagues who are not likely to be of sufficient help.

In the homework, there were few typical mathematical problems. The majority of tasks were exercises similar to, and usually more complex than, those addressed to pupils: filling out function tables, using arrows and graphs; manipulation exercises such as sorting logical blocks; using a slide rule.

The homework assignments on the whole were not intended for consolidating what had already been imparted by television lectures. On the contrary, in many cases preparatory exercises formulated in everyday language preceded lectures on a given topic; their mathematical meaning was explained later.

The homework concerned only the most important material. Many of the television lectures were not covered by the exercises.

Since some of the listeners did not receive the printed versions of television lectures and had difficulties in watching the programmes, the homework was self-contained. It was an independently designed course.

The texts of homework were prepared by the Teachers' Training Institute. The studium inspectors (supervised by the regional branches of the Teachers' Training Institute) were responsible for correcting and grading the homework.

Every fortnight the listeners received one series of problems in the form of an eight-page folder. Usually it took one evening to do the whole series. The listeners were supposed to solve these problems within two weeks and then to send the answers to designated inspectors. Since many teachers had trouble getting the texts, the deadlines were not enforced and listeners were in fact allowed to submit solutions even after some months. All in all, forty-four eight-page series were sent out in the three years. In order to qualify, for each year the listener had to obtain at least 50 per cent of the total possible points for the tasks.

The tasks began with very easy (almost childish) problems and then went on to more complex ones. The idea was that the listeners first become confident of their own capabilities, so that they would overcome their fears and would try to solve problems by themselves. They were permitted to ask others for help or to work in teams, but were discouraged from copying.

As a rule, homework consisted of one, many-part problem on a single page. After a brief explanation, one of the parts was solved as an example (at times even two or three parts) and the following similar problems were to be solved by the listeners themselves.

Model solutions were essential parts of the problems and were treated as integral parts of the questions. Consequently, explanations could be concise and there was a greater chance that the teacher would know what to do.

Model solutions were of particular importance in the process of shaping new concepts: the listener was able to solve problems by following the patterns provided and without yet having the theoretical knowledge.

For instance, one of the problems of series 1 read as follow: 'Write down: (1) all symbols which are inside only one loop, (2) all symbols which are inside at least one loop.' The model solution is shown in Figure 1. One of five parts of the problem is shown in Figure 2. (The word 'set' had not yet been used.)

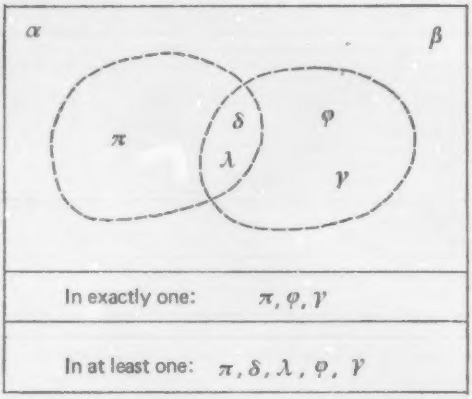

FIG. 1.

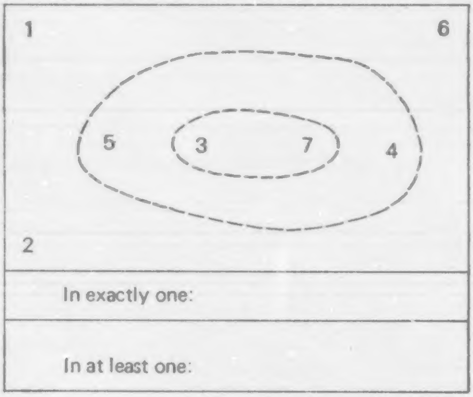

FIG. 2.

In a pre-test (organized with a group of rural and small-town teachers before the official activities of the studium and without model solutions) it was found out that about half of those teachers were confused about the meaning of 'inside at least one'. Some of them thought it meant: consider any of the two loops and write down what is inside it. Thus, if listeners were given such homework without a model solution, many of them would not be able to do it or at least would feel uncertain (a verbal explanation on television might not help much either). On the other hand, the verbal formulation of the task together with a model solution (followed by similar instances to be worked out by the teachers themselves) are the most likely (in distance teaching) to promote reasonable understanding of both the concept and the wording. The term 'union of sets' was used in television lectures and homework afterwards.

As another sample task let me mention series 19, devoted to trees as schemes of arithmetic formulas. On the first page of the folder were simple formulas for addition and subtraction and corresponding trees (Fig. 3); there were

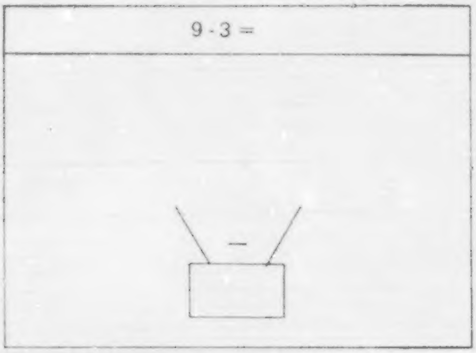

FIG. 3.

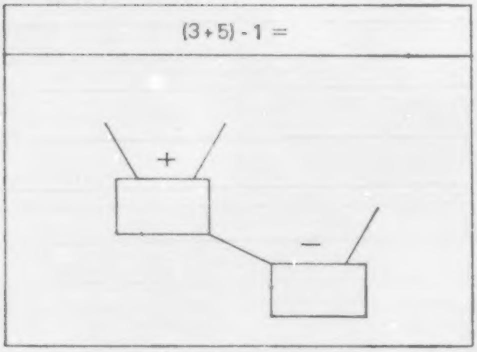

FIG. 4.

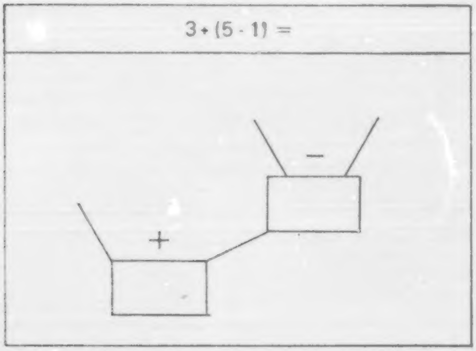

FIG. 5.

four parts of the problem preceded by two model solutions (one for addition, one for subtraction; the listeners were not supposed to know anything about such trees). Pages 2 and 3 gave two formulas with parentheses and two corresponding trees (Fig. 4 and Fig. 5). Page 4 gave a tree to be filled in and asked for the corresponding formula. Page 5 gave a formula, and asked learners to draw the corresponding tree and write down the numbers. On pages 6 and 7 there were more sophisticated trees, corresponding to formulas such as, for example, $(4-1)+(9-5)= \dots$ or $[6-(1+2)]+3= \dots$ We have assumed that after having done such a series of tasks, the teacher will have sufficient background to use the trees in the classroom (they appear, for example, in Polish textbooks for grades 1–3). Of course, there was still a question of how to organize a lesson with trees; such problems were handled by television films.

In another lesson, learners were asked to balance the given weight with minimal possible number of weights 1, 4, 16. The model solution is shown in Figure 6. For a child, this is an introduction to non-decimal systems as well as an exercise in mental computation.

The aim of another series was to present the method of colourful counters to represent add and subtract integers. The value of each white counter is 1; the value of each black counter is -1. Figure 7 shows the solution of the first problem: given counters, write in the corresponding number. One of the tasks of the series was to perform subtraction by manipulating counters. For example, in order to subtract -3 from -2, the teacher had first to represent -2 with two black counters and then to attempt to take away -3, i.e. three black ones. Since there were not enough black counters, she had to add one black counter together with a white one, so that total value of the configuration of counters would not change. Now she can take away three black counters, leaving one white, i.e. 1, as the result: $(-2)-(-3)=1$.

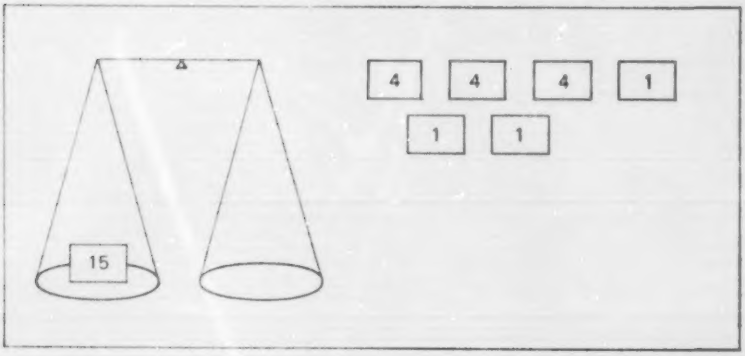

FIG. 6.

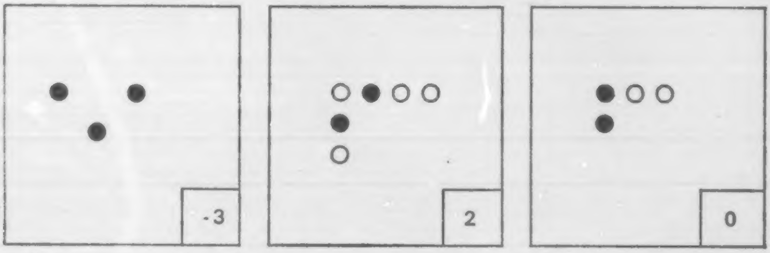

FIG. 7.

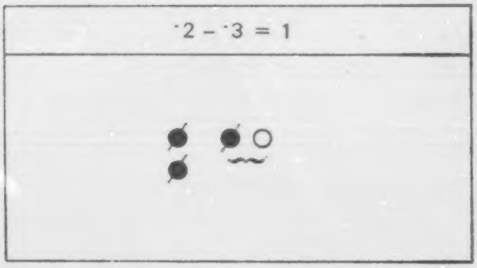

FIG. 8.

Figure 8 shows how this process was represented graphically: the brace shows the auxiliary pair added in the second step; counters crossed out are those taken away.

Consultations

Consultations were organized by regional branches of the Teachers' Training Institute and by some inspectors. However, the majority of listeners (particularly those from rural areas) had no consultations. This was the weakest point of the studium, due to the lack of competent people who could clarify the doubts of the teachers.

Examinations

The aim of examinations was to stimulate learning rather than to verify acquired knowledge, an aim which proved difficult to achieve. They were organized—with the school administration—after each year of the studium in test form, with some 60,000 listeners taking them. The examinations were held at the same time in the whole country. They were held in selected towns, generally in specially designated schools. Each listener was given a mimeographed copy of the test and was asked to solve the tasks right on the copy. The test and criteria of the evaluation were prepared by the Teachers' Training Institute.

Listeners who had failed previous examinations were allowed to sit the next year. Repeats for those who failed the first, second or third test were organized in the school year 1977/78 (after the termination of the main stream). There were no repeats between two successive examinations because of existing work and the fear that a teacher who had failed would give up the studium course and would teach children anyway. Similarly, in principle homework had to be accepted prior to the examination, but the reverse situation was also allowed. Each listener received written notification of the result of each examination with guidelines on what to do further.

Additional tasks were published for those listeners who either had not passed the examination or had not got credits for their homework. Over 50,000 teachers received diplomas, that is, credit, for the homework (or additional tasks) for each of the three years and a passing note on each of the three examinations (or a repeat).

Results

There are no hard data on how much the teachers have actually learnt and how this has affected the teaching. However, there is enough evidence to suggest that the impact of the studium on the reform of mathematics teaching in grades 1–3 was tremendous and that there were no other means to achieve this in so short a time.

Television and radio programmes helped greatly to spread throughout Poland the basic ideas of the reform. Parents and grandparents often watched the lessons on television; this contributed to better understanding of the objectives of the new curriculum.

The reform has been accepted by both teachers and parents, yet this does not mean that teaching is fully successful. There are various shortcomings and quite a lot is still to be done. In particular, many of those who have completed the studium course need further assistance. Moreover, in spite of some progress, there is still too much authoritarian teaching. It will take several years of improving instruction step by step before the goals of the reform can be accomplished.

For various reasons, an estimated 10 per cent of persons teaching mathematics in lower primary grades did not participate in the studium activities. Another 10 per cent dropped out or failed. Many of them ceased to be teachers or to teach other subjects. On the other hand, a few thousand new people have entered primary mathematics teaching without sufficient qualifications. Thus, there is still a considerable number of teachers to be trained in primary mathematics teaching; nevertheless, this number is of the order of one-tenth of the original number and is now handled by means of vacation courses.

Extended and thoroughly revised versions of the television lectures will be published in the form of a five-volume textbook and reference book for elementary teachers printed in colour. Copies will be sent to all school libraries, and this should become a sound basis for the further continuous education of the teachers.

George S. Eshiwani

The goals of mathematics teaching in Africa: a need for re-examination

Perhaps one of the most discussed issues in education in recent years in the continent of Africa is the question of the relevance of education for development. Many speakers in different forums at local and international levels have called for public education which is relevant to the African needs of today and tomorrow in content, approach and values. It is often suggested that new curriculum proposals must be seen not only as relevant but also as sensitive to national socio-economic demands. Curriculum should serve the needs of the majority and not the interests of a small segment of the society. The curriculum programmes of the 1960s, particularly those in science and mathematics, have come under attack because they seem to have served the needs of a small percentage of the school population and tended to ignore the needs of the greater percentage of the population, comprised of school leavers who did not make it to the higher reaches of the educational ladder.

This anomaly has been due largely to the fact that the curriculum changes that took place in science and mathematics in many countries of Africa were hastily introduced and were carbon copies of various curriculum packages in the West. There seems to have been little imagination and thinking about instructional goals in relation to local culture and needs. Indeed, one could almost say the prevailing attitude was that what was good for Europe or America was also good for Africa. It is this assumption that is being questioned today by the new crop of the African curriculum-developers.

Although this article is concerned with the goals of mathematics teaching in Africa, before initiating any meaningful discussion on this very important topic we must address ourselves to two significant areas, namely educational crises in Africa and the functions of education in Africa.

The present educational crises in Africa

Few people will deny the fact that we are faced with deep educational crises in Africa. Although these crises vary from one country to another, their causes are common and familiar.

First, there is the dramatic explosion in the student population in many African countries that has occurred over the last twenty years or so. In Kenya, for example, primary school enrolments have risen from 870,000 in 1961 to 2.9 million in 1976, while the secondary

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school enrolments have risen from 22,200 to 200,000 over the same period. Figures in other countries reflect a similar phonomenon. These increases have three main consequences.

First, formal education does not guarantee wage employment in the urbanized sector of the economy; nor is it appropriate for further studies. We must recognize the fact that for the majority of the children attending school, the education they receive, whether it is primary education or secondary education, is terminal. A significant number of these children cannot find jobs in urban centres. For example, in Kenya, roughly 250,000 school leavers reach the employment market every year. Out of this only 50,000 can hope to find employment or training. What kind of curriculum ought to be planned for the remaining 200,000, who must find some livelihood in the rural areas of the country?

The second consequence of the student population crises is the lowering of levels of attainment. This may be viewed from two angles. First, a rapid rise in school population without expanded classroom facilities leads to overcrowding which, in turn, makes a mockery of modern instructional methods such as the discovery method or the activity method. It reduces the teacher's options of style of teaching and restricts him to formal lecture methods. Second, the expansion of opportunities has meant that children of varying abilities are being admitted to school, often varying in age by as much as seven years in the same class. New curriculum programmes must be sensitive to educational problems posed by overcrowded classrooms and a wide ability range.

The third consequence of the student population explosion concerns teachers. The expansion of any educational system requires a proportional increase in the number of teachers. Many African countries experience an acute shortage of qualified mathematics and science teachers. Teaching is not a popular career. Graduates competent to teach mathematics find it easy to get good jobs elsewhere. Those who train to teach at lower levels often lack motivation and follow the course for lack of a better alternative. The material that such teachers are to teach needs to be presented for them in an easily accessible and comprehensible form. Every effort needs to be made to make their task as straightforward and as interesting as possible.

The second crisis concerns the enormous gap between the popular demand for education and the limited capacity of the developing countries to satisfy this demand. The latter in turn can be traced to the scarcity of resources and the pressure of competing claims on them. This raises an interesting question: Who should be taught mathematics?

The third crisis is the crisis of relevance of imported institutions and structures. The formal school as we know it is largely a creation of industrialized society and the school systems in Africa are therefore transplants of the school systems of that industrialized society. It should not be surprising that the curriculum transplantation that has taken place over the decades has resulted in much tension. One of the questions that must be considered in re-designing curriculum for Africa is how to resolve this tension.

Purpose of education

The basic goals of education in any society may be summarized as the preservation and transmission of culture, the inculcation of appropriate values and attitudes, the imparting of skills and the promotion of innovative, creative and critical abilities. Scopes[1] has listed these goals slightly differently, as utilitarian, social, cultural and personal.

It is taken for granted that any meaningful curriculum revision must take into account either of these two frameworks or a combination of the two. But, to what extent should the national educational goals be considered in the revision of a mathematics curriculum? Mathematics may help in imparting relevant skills for technological development or in the promotion of creative and critical abilities, but how does it help to preserve and transmit culture? How does it help to inculcate appropriate values and attitudes? Maybe we should look at some of the things being taught and see if they assist in the national goals. For example we might consider whether or not transformation geometry is important to a particular country. Similarly, we ought to ask ourselves to what extent present objectives of mathematics education fulfil national goals, what the limitations of these objectives are and how they could be made more meaningful.

Present objectives and limitations

The revolutionary changes in concepts of mathematics teaching in the 1960s resulted in a statement of objectives that are presumed to be valid up to the present day. Two common premises for these objectives were the following:

1. Mathematics teaching should employ activity methods rather than drilling and memorization Pupils should understand the reasons behind the methods they are using; they should not simply apply them in a mechanical fashion.
2. There is no mathematical principle, however abstract, which cannot be presented in some meaningful form to a schoolchild of any age. School pupils should, therefore, be introduced to the major principles which underlie all mathematical thought and which unify concepts, then most of the drilling and practice of the traditional approach can be dispensed with.

Nearly all the modern mathematics programmes in Africa aim to do the following: (a) develop basic mathematical skills and an understanding of number pattern and shape, and to develop simultaneously social, domestic and commercial applications of these skills; (b) instil into students deductive and critical methods of thinking that lead to intellectual independence; (c) train students in generalizations; (d) arouse the interest and stimulate the curiosity of students in mathematics; (e) lead to an improved and more accurate way of communication in natural language, in scientific terminology and in graphical and diagrammatic communication; (f) lead to a search for the fundamentals in any real problems.

Little attention seems to have been paid to the actual content and to the cognitive development of the pupils. As a result there are great gaps in the modern mathematics programmes being used in many countries of Africa, and criticisms of the programmes make the following points:

The courses are overloaded, and each topic is treated superficially, with the result that pupils forget what they have learned.

Most pupils find the course interesting and enjoyable, but certain topics such as linear programming, three-dimensional vectors, and loci, are too difficult for average O-level candidates.

The language and mathematical symbols used are often unnecessarily complicated.

The sequence in which topics are introduced does not always help pupils to build on previous knowledge, nor to understand the ways in which the various aspects of mathematics are linked.

There are far too few practice examples given in the books; those that are given often do not present an adequate progression in difficulty.

Insufficient attention is given to the development of computational skill. Many pupils fail to develop speed and accuracy in the straightforward manipulation of numbers, which hampers progress in more advanced topics.

Too much time is spent on topics which are of little relevance to those who will not take mathematics to upper secondary level. Transformation geometry and matrix algebra, for example, are overdone.

Conversely, applied topics needed for science are often inadequately treated. Science teachers complain in particular that pupils lack competence in solving proportion problems. For example, a straightforward problem involving Boyle's or Charles' law, which should take only about five minutes to solve, may require a whole period. Similarly, upper secondary level geography students often have great difficulty in solving map-scaling problems. As one teacher expressed it: 'The language of science is mathematics; we expect pupils to speak it well.'

The absence of formal proofs in the treatment of geometry is a serious omission. While it is important that pupils should investigate the properties of circles, triangles, etc., inductively, it is also important that they should acquire an understanding of how these properties can be derived deductively.

Although some attention is paid to geometrical construction in mathematics, teachers complain that pupils do not develop an adequate level of skill. In one school it has been observed that a substantial proportion of secondary students are unable to bisect an angle accurately, or to drop a perpendicular from a point to a base. The author has seen secondary school pupils who need to be taught geometrical drawing before they could begin a course in carpentry at a village polytechnic.

Teachers complain that most pupils develop insufficient skills in manipulating algebraic equations. Consequently, they have difficulties in tackling more advanced algebra.

These criticisms apply to most maths curriculum programmes in Africa, and are compounded at primary school level by the problem of language. Overloaded in content, the mathematics curriculum in Africa is also overloaded in its vocabulary requirements. Where English or French is the medium of instruction, it is in most cases a second language for the pupil, who has immense problems of vocabulary, structure and symbolism.

In addition pupils have severe comprehension difficulties with story problems. Cultural factors may create further difficulties. A number of story problems may involve objects and situations which are likely to be familiar only to pupils from urban, high-income backgrounds. For example: 'There were nine children at a party. Each child ate two cakes and eight cakes were left over. How many cakes did mother buy?'

A look at the possibilities

There are many objectives for mathematics teaching that could be proposed, based on the discussion above.

Mathematics should, as already mentioned, develop the basic skills of numeracy and an understanding of pattern and shape, together with their domestic social and commercial applications. Pupils should also learn elementary ideas of how mathematical models are fitted to practical situations.

Mathematics courses should also instil deductive and critical methods of thinking, leading to intellectual independence and should enable pupils to think abstractly so that, later in life, they can sift facts relevant to problems and make rational decisions.

Mathematics is, we believe, attractive for its own sake and a good curriculum should arouse the interest and stimulate the curiosity of pupils. Those whose education is ending may find an abiding interest in it and, hopefully, more than hitherto will be sufficiently interested to continue with the subject. Mathematics is an effective language and is much used in other fields. The secondary school curriculum should improve mathematical communication both as an aid to science and in the use of graphical and diagrammatic visual aids.

Mathematics is full of generalizations. It is important that pupils learn how to make and judge generalizations for adult life. Looking for deeper structures is a typically mathematical activity and teaching should bring out the importance of searching for the fundamentals in any real problem.

In Africa mathematics holds an important place in the school timetable as a necessity. Not only do all pupils need to learn basic skills but many also need more mathematics in order to train effectively to be clerks, technicians, professionals, scientists and so on.

The syllabus should take this into account. Its content should reflect the requirements of agriculture, industry, commerce or the universities. On the other hand we should not give too specialist a mathematics education at the risk of being counter-productive by teaching material too difficult to be absorbed.

The teacher in the classroom should be particularly concerned with the personal development of the child, the stimulation of curiosity and a critical outlook. Mathematics is well suited to this kind of activity. The material should always be presented in a way that interests pupils and encourages them to think for themselves, yet too often mathematics is learnt as received truth. Formulae like $c = 2\pi r$ are produced, as if by magic, and followed by sets of problems. No topic should be included which cannot be explained in a manner that the pupils can understand.

The ability to reason logically and deductively is something that all pupils who go through to the end of primary school should have a taste of; this is an area in which even our university students have difficulty at present.

This is not to say that teachers should not give homework but it is incumbent on the teacher to make the material as interesting and digestible as possible. The less able pupils will quickly lose interest if difficult algebraical manipulations make understanding difficult.

Implications for the syllabus

We assume that in the future there will be an ever-increasing enrolment in the primary school but that secondary education will be highly selective.

The curriculum should include number and number operations; fractions, ratios and percentages; decimals; measurement and approximations; reading of simple graphs and tables and social arithmetic; negative numbers; the use of formulas; simple geometry, mensuration; and some statistics.

To prepare pupils for secondary school it should also include informal methods of algebra; geometry; simple trigonometry.

The secondary school curriculum must assume that the pupil can assimilate some deductive geometry, sufficient to appreciate a deductive chain and arguments therewith.

There needs to be greater grounding in algebra than is covered by most textbooks in use. Algebra is needed for science and for most further training programmes.

The terminal Primary School Examination will certify the standard of school leavers, but given the wide ability range examined at this level, perhaps it might be necessary to use two examinations. One would be a paper suitable for all. The second would be an examination designed for those going on to secondary school, which they would sit in addition to the first paper. Those wishing to do mathematics in the secondary school would need to pass this paper, or get a very high grade in the first paper.

A very important area that must be considered along with goals of maths teaching is that of materials. With a wider ability range amongst both pupils and teachers, great care in the production of materials is required. Experience shows that self-teaching books present several difficulties.

First, there is a problem of language, which impedes understanding especially in a course of books which introduces many new words.

Second, the content of the chapters is often concealed in questions. For the experienced teacher this is no problem, but for novices the lack of any real sign-posting of the key points can lead either to their omission or to time being wasted covering the whole chapter to avoid missing anything important.

Third, we must be careful that texts do not attempt to impose an approach that creates a conflict between the relationship the book assumes and that which the society expects to exist between pupils and teacher. For example Kay[3] writes about the Kenyan New English Primary Course, which wanted the teachers to be more the pupils' friends than leaders in the classroom. In the local community the pupils were expected to respect and instantly obey the teachers as their elders and, therefore, their betters. We must also bear in mind that teachers' conceptions of teaching were formed in eleven to twelve years of very formal teacher-centred education in which mathematics was often reduced to the application of given formulas. Weaning away from this has to be done gently.

Fourth, with an increasing ability range it is desirable that the material in textbooks be ordered very carefully with a generous number of examples given for each stage of development. This would help both teachers and pupils.

Based on the above arguments, there seems to be a need for the following package of books to achieve the goals described:

BASIC TEXT

There would be one book per year. Each chapter would contain a brief account of the material and suitable examples, and a summary at the end of each chapter.

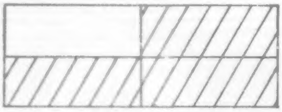
TEACHER'S TEXT

This would contain answers and detailed suggestions for a variety of strategies using very simple equipment to introduce the parts of topics in ways that pupils can understand, a discussion of special points to note and games that can be used to consolidate the topic. Highly experienced teachers might have less use for such a book than beginning teachers. A comprehensive index would be essential. An example of the suggestions the teachers' book would contain follows here:

The equivalence of fractions

Before pupils can add fractions with different denominators they need to understand equivalent fractions. These can be introduced in the following way:

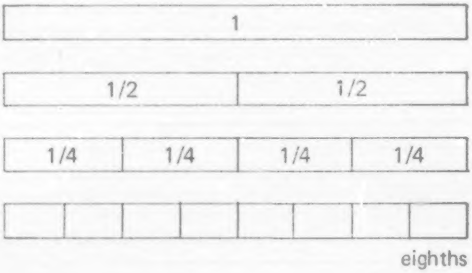
Example 1. Give each pupil a rectangular sheet of paper. Tell them to fold it into four, unfold and shade three-quarters of it:



Fold the paper once more; now the pupils will find that 6/8 of the paper are shaded. So 3/4=6/8. This can be done with other fractions, e.g. 1/3=2/6=4/12.

Folding into thirds, fifths, etc., is not so easy as folding into halves, quarters, eighths, etc.

Example 2. Strips of paper the same length but marked differently can be made by pupils and put next to each other:



So: 1/2 = 2/4 = 4/8 = 8/16, etc.;
3/4 = 6/8 = 12/16, etc.

From examples such as these the pupils should come to see that, for example, 5/7 = 10/14 = 15/21, etc.

Revision exercises

These are needed in the form of a book or stencils for duplicating by schools. These papers provide an easily marked set of graded exercises. The pupils answer the tests on special answer sheets which can then be inserted in the appropriate page of an answer book consisting of sheets through which only the correct choice of answer can be seen.

Workbooks

Workbooks are useful especially at the junior level. They save teachers and pupils a lot of time, they add an individual element to the work, they help set a standard for tidiness, neatness and so on and they are particularly useful for geometry.

Notes

1. P. G. Scopes, *Mathematics in Secondary Schools*, Cambridge University Press.
2. S. Kay, 'Curriculum Innovation and Traditional Culture', *Comparative Education*, October 75.

Ricardo Losada Márquez
and Mary Falk de Losada

Mathematics programmes: first aid

Although in the beginning the revolution in school mathematics met with open resistance in most countries, in the face of pressure from university teachers and the new programmes this resistance has been undergoing a process of change until it has become a sort of 'underground'; those connected with mathematics teaching feel the need for change.

In many countries of the world the impetus for modernization in mathematics comes from two main sources: international movements which disseminate new points of view through conferences and publications; and local professionals who have the opportunity, mainly abroad, of familiarizing themselves with new trends and events. As a result, the perspectives of the renewal movements tend to be out of line—and sometimes actually incompatible—with national needs and resources.

The adaptation process is bound to have sociological and psychological, as well as academic, implications. However, in these movements there tends to be an inaccurate assessment of the progress made towards meeting the proposed aims, since any deficiency or failure is thought to be the fault of forces unrelated to the essence of the mathematical reform. This is particularly evident in the lack of foresight with which the organizations responsible carry out their reform programmes.

It is the aim of this article to show how the revolution in mathematics teaching has, in some parts, been distorted by the absence of several factors which ought to come into play; and how the resistance to change has become so ingrained that, rather than express its misgivings, it suppresses them and acts in accordance with them. It will also be necessary to say a word about certain areas of mathematics where a misguided approach has contributed to this paradoxical and counter-productive state of affairs.

The basic problems

The attitude of the average medium-level teacher towards the modernization of mathematics is ambiguous. On the one hand, he probably realizes that he has not been adequately trained and that the academic level of his classes needs to be improved. On the other hand, however, he himself has not mastered the new content or the new formal methodology of mathematics and is not motivated to implement the specific changes they require of him.

Even under optimum social conditions, the

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idea that mathematics is a logico-formal system and should be taught accordingly met with fierce resistance from teachers; originally, because of their own lack of training or knowledge, but increasingly because of the failure in which it resulted for many students. These misgivings led, *inter alia*, to the so-called 'back to basics' movement.

From the student's point of view, modern mathematics, as it was originally conceived, demanded at an early stage a degree of conceptualization of which the average student was incapable. At the same time, formalization reduced the emphasis on the applications of mathematics, and hence the pupil's motivation to understand and master it. In addition to this, parents could recognize no trace of the mathematics they themselves had learnt at college; so there was hardly any of the important support that is the family's contribution to the educational system. Furthermore, society in general became increasingly aware of a certain élitism inherent in the over-formalized teaching of mathematics and clamoured for the return of a more balanced and democratic approach at the teaching level. Finally, there was the discovery of numerous scientific pointers to the erroneousness of some of the trends of modern mathematics, the main point being the evidence offered by the psychology of learning that more emphasis should be given to concrete experiences and particular situations during a large proportion of school life, giving intuition a wider role in mathematics learning. At the same time, the new orientations and increasing importance of applied mathematics also obliged modern mathematics to develop differently from the way at first envisaged.

None of the foregoing factors have had the same impact on the renewal of mathematics teaching in Colombia and other countries with similar educational and social characteristics. Consequently, the renewal is continuing along the lines originally laid down with few modifications. It could be said that as a movement it has not matured. Let us now look at the social factors responsible for this.

Although the first attempts at modernizing the teaching of mathematics in Colombia encountered resistance from the teaching profession, at both university and secondary level, this resistance dwindled when faced with the following circumstances.

The generally low level of teacher training created an atmosphere of insecurity among middle-level teachers. First, they recognized many gaps in their own performance and achievements in the classroom; and dared not carry on an open controversy with the university teachers and representatives of the Ministry of Education who had promoted the changes. Moreover, the absence of a national academic trade union still further undermined the teaching profession's active participation in the renewal process. Secondly, the middle-level student body has traditionally been, and continues to be, mainly university oriented or, at least, has aspirations to go on to higher education. Although secondary education has begun to diversify in view of the fact that the vast majority of students finish their studies at that level, the diversification has not been really effective. At best, secondary education can be regarded as being at a transition stage. This manifestly influences student attitudes to the mathematics programmes since, however far-fetched and difficult they may appear and though they are neither relevant nor coherent, they are accepted almost with resignation because the student sees his secondary education not as a specific preparation for a job but as a vague passport to possible further studies.

If, moreover, we consider that many of the parents of secondary-level students in Colombia never received any secondary education themselves, we realize that the modernization of mathematics does not receive any effective assessment from that quarter either.

Even though in some countries the three pressure groups (teachers, students and parents) have acted as a filter, checking certain excesses of the mathematics-modernization movement and, in the process, stabilizing and transforming the movement, this has not been the case in Colombia or other countries with a similar social background.

Modern mathematics is continuing on its course unchecked, without constructive criticism, with lamentable contradictions and no less lamentable consequences. In the first place, total reform of official study programmes exists on paper. These reforms are on the whole sensible as regards curriculum content, but there is a disproportionate emphasis on some topics while others are totally ignored: the approach to some of the topics dealt with is extremely abstract, and others are introduced too early in the programme. There are faults in the sequence of topics, lack of perspective and a tendency towards formal, abstract methodology.

However, the official programmes to some extent exist in a vacuum, for it appears from various surveys that while teachers ask for textbooks that follow the official programmes, many of them (though by no means all) make only nominal use of these books and continue to teach the mathematics they themselves were once taught, and by the same methods.

The fact is there is no longer any argument about the need for change, but the available alternatives are full of irregularities and disadvantages which lead to ultimate failure. Because the status of the advocates of reform inhibits open protest, open resistance has turned into a sort of civil disobedience.

It is evident that there are people who recognize the contradictions in this situation and have tried to strengthen the infrastructure needed to sustain any reform of such dimensions: advanced teacher training, diversification of secondary education, compilation of suitable textbooks, programme revision, the cultivation of critical, well-informed public opinion. These are all sensible measures whose introduction and consolidation will require a sustained, broadly based effort. However, from the mathematical viewpoint it is possible to identify certain particular trouble spots where immediate action is called for in the interest of a healthy renewal of mathematics teaching. Some of these are discussed below.

Language and symbolization

The aim of the early advocates of symbolization in mathematics was to diminish the role or influence of intuition in the process of logical reasoning and rid the words used of extraneous connotations or semantic vagueness. There are understandable historical reasons for their mistrust of intuition. However, this does not apply to the middle-level mathematics student. He, on the contrary, must cultivate and perfect his intuition, making use of appropriate symbolization when this helps to pinpoint or clarify concepts. In short, symbolization must help rather than hinder the learning process.

Similarly, the language of mathematics is a vehicle for the clear expression and understanding of ideas. For many years it has been considered inadequate to teach a foreign language by having students learn reams of vocabulary and memorize grammatical rules. The same applies to mathematics. Mathematics cannot be reduced to a collection of words, even if we add the rules for combining them. Learning a new language necessitates being able to express ideas and construct sentences with a meaning, and the same goes for mathematics. The purely mechanical acquisition of mathematical vocabulary through learning by heart must be superseded by teaching that underscores the dynamic formulation of interesting ideas (hypotheses, theorems) always in accordance with predetermined rules.

Superficial, memory-based learning, both the symptom and result of inadequate teacher training, has turned mathematical language and symbolization into elements of a static, sterile science. There is an urgent need to show students how to use them as a means to an end and not as an end in themselves.

Concept of equivalence relation

The mechanism of equivalence relation is used to formalize intuitive mathematical concepts, from the concept of the number to that of the vector. The introduction of the correspondence relation between sets or of the equivalence relation between directed segments, for example, gives rise to the definition of 'number' and 'vector', respectively. These definitions *per se* create havoc. How is it possible, in the name of formalism or mathematical conceptualization, to ask the pupil to change his intuitive concept of the number one which he acquired at the age of two or three, for that of the class of all unitary sets? When it is so simple to pass from directed segment to vector by fixing the initial point—a visual and intuitive criterion—why define 'vector' as a class of equivalent directed segments?

It can be convincingly argued that the concept of equivalence relations and the consequent partition of sets can be mastered by intuition. Even though this is so, it represents an initial level of conceptualization which frequently explains the finite in terms of, or 'reduces' it to, the infinite. Equivalence relations and their logical implications are of interest for the purpose of deriving mathematics from, or basing it on, the theory of sets, but are not necessary for understanding and mastering the corresponding concepts.

And when the pupil is asked to operate with these equivalence classes, as is the case in vector addition, we are moving on to a second level of conceptualization. From that moment, a geometrically intuitive operation loses its simplicity and is lost among abstract devices. Similarly, the construction of whole numbers as classes of ordered pairs of naturals with the subsequent definitions of addition and multiplication, and any other construction of this kind, militates against intuitive comprehension and should be eliminated from secondary-education programmes.

Applied mathematics

In contrast to the two previous cases, it can be said that in the field of applied mathematics there has been too little reform rather than too much of it. While the elements of the theory of sets are repeated as a sort of ritual year after year, no room is found for probability, statistics or applications of linear algebra appropriate to middle-level education; or they are merely included as optional subjects (and there is never time for optional subjects). Apart from its recognized importance in relation to science and to contemporary society, applied mathematics has an undeniable formative value in the process of mathematics learning. Only in the context of these applications can the secondary pupil master the process of constructing a mathematical model for use in a concrete situation. It is through applied mathematics that the distance between mathematics and the world is bridged, that countless students are motivated and that it is possible to make a start on diversification at the secondary level of formal education.

Geometry and intuition

The authors of the famous onslaught on Euclid at the International Mathematics Congress in 1959 wanted to draw attention to the fact that the amount of time devoted to Euclidean geometry was excessive, especially in view of its imperfections as an axiomatic system, and that many important subjects were omitted from traditional curricula. But their words have had an unforeseen effect. Geometry has virtually disappeared from study programmes and with it a valuable instrument of intuition. In almost all fields of mathematics, the first step in conceptualization is taken by moving from concrete cases to geometrical representation. In subjects like linear algebra this step requires specific knowledge of both plane and solid geometry; but, in any case, insufficient acquaintance with geometry makes the use of geometrical representation worthless as an instrument of understanding. The trio, concrete intuition, geometrical intuition and formalization, is a powerful and almost infallible combination in teaching and learning mathematics. To omit or weaken the intermediate stage of geometrical intuition is to weaken the whole process.

The above are merely a few illogical and controversial facets of mathematical reform which tend to obscure its successes and its other positive aspects. Pending the development of the various necessary support programmes, the judicious reinforcement of the educational infrastructure and the emergence of a sensible, long-term approach to the present transition period, due attention to these crucial points will provide first aid. These are changes of focus which neither damage nor seriously disturb the educational structure, but instead give relevance, consistence and common sense to the movement and process of modernization.

Manmohan Singh Arora

Whither secondary mathematics? The Indian experience

Undoubtedly, the future historians of mathematics will not fail to record the tremendous impact of the 'movement' of the 1960s in mathematics, known by the name of 'modern mathematics' or 'new* mathematics'—a movement marked by radical changes in the curricula and, by no means confined to any one country or, for that matter, even to a set of culturally akin countries. Today, the implications and effectiveness of this movement are being debated vehemently at different forums—teachers, teacher/educators, subject-experts, curriculum-designers and even parents; through seminars, workshops, professional national and international meetings, journals and even the popular press.

We review for the reader the origins of this movement and its implications *vis-à-vis* its 'spread' to developing countries and, in particular, India.

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The origins of 'modern' or 'new' mathematics

It was the singular peacetime achievement of the USSR, that of launching their first sputnik into space, in 1957, that took the whole world by surprise. In the Western world and, in particular, in the United States, this incredible feat was considered to be a consequence of the supremacy of the Soviet Union in science, mathematics and computer know-how. To quote from Kline:

> This event convinced our [United States] government and country that we must be behind the Russians in Mathematics and Science and had the effect of loosening the purse strings of governmental agencies and foundations [1, p. 20–1].

This triggered an impetus to overhaul and reform the school mathematics curriculum so that 'able' students could be brought more quickly to the frontiers of pure and applied mathematics. Several committees were set up and projects were initiated to make recommendations for and to develop new curricular materials in mathematics—for example, the School Mathematics Study Group (SMSG), the University of Maryland Mathematics Project (UMMP),

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* Historically, the nomenclature 'modern' and 'new' came in vogue at different times. However, we shall not concern ourselves with the difference.

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the University of Illinois Committee on School Mathematics (UICSM), the Secondary School Curriculum Committee of the National Council of Teachers of Mathematics, etc. We shall not detail the work and recommendations of these and other committees and projects here, but instead refer the reader to Willoughby [2]. The philosophy and thinking of these committees and projects are best summed up in Kline. To quote him again:

> Their main message was that mathematics education had failed because the traditional curricula offered antiquated mathematics, by which they meant mathematics created before 1700 [1, p. 22].

And, as he further states it beautifully: '*The slogan of reform became "modern mathematics"*.'

By implication, therefore, developed a distinction between the 'pre-reform' and 'post-reform' curricula in mathematics. The pre-reform curricula began to be identified as curricula in traditional mathematics, comprising mainly of arithmetic, algebra, trigonometry, geometry of Euclid, etc. The post-reform curricula began to be known as curricula in modern mathematics, recommending, more or less, unanimously: (a) the use of set theory to introduce numbers and their properties; (b) that Euclid must go[1] and be replaced by transformation geometry; (c) the filtering down, to the secondary school level, of several advanced topics from the theory of numbers, abstract algebra, linear algebra, topology and, of course, calculus.

Further, the approach to curricula in modern mathematics was to present a unified overview of mathematics through the use of sets, operations, mappings, logic and structure. It was deemed sufficient that introduction of these curricula would require training and retraining of teachers, on a colossal scale. We quote here a paragraph from the Foreword to Kline's work by Mr Francis Keppel, United States Commissioner of Education who, in 1963, speaking for the reform in mathematics curricula, writes:

> It is not only that most teachers will be completely incapable of teaching much of the mathematics set forth in the curricula proposed here, most teachers would be hard put to comprehend it. No brief period of retraining will suffice. Even the first grade curriculum embodies notions with which an average teacher is totally unfamiliar. Nonetheless, these are curricula toward which the schools should be aiming. . . .

And so began the 'movement' of modern mathematics!

In the countries of Europe and the United Kingdom, a more or less simultaneous 'overhaul' began. The deliberations of the Royaumont seminar of the OEEC highlighted the need to reformulate and recast syllabi in mathematics, backed by economic, technical, cultural and scientific reasons. This was followed by creation of working groups and commissions from 1964 to 1967 and evaluation, experimentation, implementation and gradual generalizations of new programmes from 1968 to 1973.

Developing and underdeveloped countries followed suit, usually with a time-lag of four to five years, prodded often by, of course, the erroneous reasoning that 'we must "modernize" our curricula in mathematics if we are to keep up with the western world'.

And so most of the countries in Africa, in South-East Asia and, of course, India, became participants in the 'movement' of modern mathematics at different times during the 1960s. An examination of these developments and their implications is beyond the scope of this paper. We refer the reader to Freudenthal [3] for experiences of some of these countries. We shall dwell, in some detail, on the Indian experience in the rest of this article.

The Indian experience

In India, the first attempts at 'modernizing' curricula in mathematics were initiated around the middle of the 1960s. The process was strikingly similar to that in several other developing and even developed countries: professors and subject-matter experts from the universities recommended the change, teachers were 'trained' in summers and in holidays and more and more materials 'pushed down' to the school level. A conference was held in Bangalore, India, in 1973 with delegates from the United States, the United Kingdom and India. The conference made the following recommendations: '1. Mathematics is to be compulsory for *all* students for the first ten grades (age 16+) 2. There should be a uniform syllabus for all students through the tenth grade [4, p. 37].'

The delegates to the conference confessed that 'not all had any experience with present day instruction in classes I (age 6+) to X (age 16+)'. They, however, advocated a curriculum for the twelve years of schooling which can essentially be termed 'modern' [see 4, p. 22].

There is another facet of the Indian experience which must be reviewed. India, when it gained independence in 1947, was endowed with an educational system suffering from its colonial and feudal heritage. Its people, therefore, were seized by the fact that the educational system needed a radical transformation. We do not feel the necessity of detailing the work and recommendations of various committees and commissions on educational reforms, appointed since independence. Significant, however, is the monumental work of the Education Commission of India (1964–66) who, in its report on *Education and National Development* advocated a restructuring of the educational system on a broadly uniform pattern of ten years of secondary schooling, followed by two years of higher secondary, followed by three years of undergraduate education at a college or university towards a first degree. This pattern has come to be known as the 10+2+3 pattern of education. The commission's report was discussed in Parliament and, in 1968, a National Policy Resolution was adopted by the Government of India which, *inter alia*, stated that the government was convinced that a radical reconstruction of the educational system, along the broad lines of recommendations of the Education Commission, was essential for the economic and cultural development of the country, for national integration and for realization of the ideal of a socialistic pattern of society. The resolution further stated that it would be advantageous to have a broadly uniform structure of education in all parts of the country. The resolution defined the ultimate objective at the school stage to be the 10+2.

A significant recommendation of the 10+2 pattern that concerns us and merits our attention is that science and mathematics, hitherto denied to almost 50 per cent of the students, are now to form an integral part of one's education to age 16+. This necessitated a fresh look at the curricula in science and mathematics. In terms of mathematics, this recommendation became synonymous with introducing modern mathematics in the school system.

A decade of experience

A decade of experience with modern mathematics has raised more questions than it has cared to answer. It is found that children do not quite accept the rigour, logic and structure of modern mathematics and thus, the 'new' topics advocated by the curricula in modern mathematics also provoke rote learning and memorization. Incidentally, we should remark that these drawbacks were originally attributed to traditional mathematics which, the curricula in modern mathematics had sought to get rid of.

It is also found that a vast majority of teachers did not really appreciate the spirit of modern mathematics and the demands it made of the teacher. Its enriched and ambitious content, emphasis on understanding unifying concepts and structures, and call for the use of the methodology of discovery-learning did not really 'carry' all the teachers with it. The result, therefore, was that the teacher's lack of enthusiasm, understanding and appreciation of modern mathematics would, in due course, became apparent to the pupil, and would, in turn, create a distaste for mathematics in the child, thus creating a rather vicious cycle—an ill-prepared, disinterested teacher teaching mathematics, infecting the child with his disinterest, who, in turn, becomes disinterested in mathematics.

These experiences, in varying degrees, were replicated over and over again in different countries which had opted for modern mathematics. India, of course, was no exception. With its 75–80 million children studying mathematics at school, and with approximately 2 million teachers teaching them, their diverse economic, cultural and social backgrounds, many languages, varied customs, manners and mores made the situation was even more perplexing.

There are at least four other conditions of the Indian scene that we must underscore:

1. The Indian economy is primarily agrarian, with more than 80 per cent of its approximately 680 million people living in the villages and off the land.
2. The Constitution of India provides for compulsory and free education to all children to age 11+.
3. Education in India is a state subject in that the state governments are free to determine and implement their educational policies and objectives. The central government, however, acts as a cementing force between the states in order to ensure national integration and unity in diversity. The central government is, therefore, able to co-ordinate educational policies of the States through meetings of their Ministers of Education.
4. The central government also initiates and promotes educational research, develops model curricula and curricular materials, suggests curricular changes besides assisting the states in adopting/adapting to these changes. For this purpose, the National Council of Educational Research and Training (NCERT) was set up by the Government of India, some twenty years ago, and has been the major instrument of change in education in the country. Based on the 1964–66 report, of the Education Commission of India, NCERT has prepared an 'approach paper' [5], for the curriculum for the child in his first ten years of schooling (i.e from age 6+ to 16+), which was discussed at several forums—from teachers' professional organizations to meetings of the Ministers of Education of the states—before a consensus was reached.

With mounting criticism of modern mathematics from the educationists, teachers, parents and even students, NCERT undertook to have a fresh look at the mathematics curricula in schools in India, coinciding incidentally with the switch-over to the 10+2 pattern of education. The author of this article was a member of the National Committee on Curriculum set up, for this purpose, by the Government of India. A large number of teachers, teacher/educators, representatives of the State Institute of Education and of the State Institute of Science Education, pedagogues, subject-experts and educationists were involved at several different forums to review the existing situation in India and propose changes to make mathematics relevant to our environment and to meet the needs and aspirations of our people and our country.

We find very relevant the point of view of the famous philosopher and mathematician, Alfred North Whitehead, who in his essay, 'Mathematics and Liberal Education', published in *Essays in Science and Philosophy*, writes:

> Elementary mathematics . . . must be purged of every element which can only be justified by reference to a more prolonged course of study. There can be nothing more destructive of true education than to spend long hours in the acquirement of ideas and

> methods which leads nowhere . . . there is a widely spread sense of boredom with the very idea of learning. I attribute this to the fact that they [the students] have been taught too many things merely in the air, things which have no coherence with any train of thought such as would naturally occur to anyone, however intellectual, who has his being in this modern world. The whole apparatus of learning appears to them as nonsense. . . .
>
> Now the effect which we want to produce on our pupils is to generate a capacity to apply ideas to the concrete universe. . . . The study of algebra should commence with a systematic study of the practical application of mathematical ideas of quantity to some important subject.
>
> In geometry, likewise, the curriculum should be rigidly purged of all propositions which might appear to the student to be merely curiosities without important bearings. . . .
>
> What, in a few words, then is the final outcome of our thoughts? It is that the elements of mathematics should be treated as the study of a set of fundamental ideas, the importance of which the student can immediately appreciate; that every proposition and method which can not pass this test, however important for a more advanced study, should be ruthlessly cut out. . . . Again this rough summary can be further abbreviated into one essential principle, namely, simplify the details and emphasize the important principles and applications.

What Whitehead remarked about the curricula in traditional mathematics is just as valid for the curricula in modern mathematics. The student must be taught to appreciate the basic concepts of mathematics. He should be exposed to less and 'quality' mathematics rather than more and 'quantity' mathematics in a way that he is motivated to want to further study mathematics on his own. The motivation for the non-mathematician must, of course, as much as feasible, be non-mathematical, that is in the study of real-life situations and problems. This should pose no difficulty since almost all branches of mathematics arose in response to such problems.

We outline below the thinking regarding mathematics at various levels that has emerged as the consensus from discussions at various forums.

Mathematics for the primary school

The Indian experience, like that of most of the other developing countries, is that a large percentage of its students do not continue beyond the primary school. It is, therefore, pertinent that minimal sets of goals be laid down for this stage to meet requirements of both groups of pupils, namely those for whom this education will be terminal and those, in the minority, who will go on to further study.

We state below the goals proposed for the study of mathematics at this stage of schooling:

1. Development of numeracy and its applications to real-life situations.
2. Development of manipulative skills in mathematics, particularly in basic arithmetic.
3. Translation of simple, real-life situations into arithmetical problems, thus making the child appreciative of the power of mathematics.
4. Development of intuitive geometrical notions.
5. Ability to draw appropriate inferences—for example, observing patterns in numbers, reading and drawing of pictographs, etc.

In introducing the necessary mathematics, it is important to take into account not only the vocabulary of the child but also his stage of intellectual growth. In fact, in the report of Panel I (Primary Education) of the Regional Conference on Development of Integrated Curriculum in Mathematics for Developing Countries of Asia (December 1975), of which panel the author of this article was one of the leaders, exhorted that mathematics, in the first two years of the primary stage should be taught through language and language through mathematics. We refer the reader to Arora *et al.* [6] for a preview of

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the type of materials already developed and being developed for this stage of schooling in India.

Mathematics for the middle school

Of the students that will go through this stage, again a vast majority will drop out and only a small minority will proceed to the next stage—at least, that has been the Indian experience so far. It is therefore required that these students begin to 'do' some mathematics and yet not be afraid of it. There is also an obligation to the small minority of students who will go on to the secondary and higher secondary stages, in that they should feel 'secure' in what they are doing in mathematics.

Specifically, the goals for the study of mathematics at this stage of schooling are the following:

1. To enable the students to acquire the knowledge of numbers, operations defined on them and their properties.
2. To apply the knowledge acquired to problems of daily life.
3. To develop the ability to create and discover new mathematical ideas, to see new relationships and generalize from them, to see mathematical patterns and structures.
4. To collect, classify and interpret data.
5. To develop manipulative skills and other components of mathematical competence.
6. To develop geometrical thinking, and to familiarize with space and spatial relations.
7. To develop a critical attitude, to compare different possibilities in a given situation, to analyse alternatives and to justify choice.
8. To develop the ability to think on logical lines.
9. To appreciate the beauty and power of mathematics.

We invite the reader to refer to the works of Arora [7] and Arora and Passi [81 for an examination of the type of materials developed for the children aged 11+ to 14+ in Indian schools.

Mathematics for the secondary school

Of the students entering the secondary school, again a majority will finish their studies at age 16+, up to which age they receive a broad-based education, including science and mathematics. Of the remainder, who will complete the last two years of the secondary school, some will aspire to become engineers, some will go on for medicine and other professional fields, while only a small percentage will enter university education and still a smaller percentage will opt for mathematics. We state below the objectives for studying mathematics at this stage of education:

1. To prepare students who want to go in for further studies in mathematics, physics, chemistry, biology, economics, engineering, etc.
2. To enable students to apply mathematics in their professions (when they leave school) and to enable them to use mathematics productively in various fields of life, such as banking, farming, etc.
3. To enable the students to think logically, quantitatively, precisely and to develop in them the habit of thinking mathematically.
4. To develop in students the proper understanding of mathematical concepts and the ability to apply them through simple mathematical modelling.
5. To develop in students the appreciation for power, limitation and cultural importance of mathematics in human and national development.

We refer the reader to the works of Singh and Arora [9], and to those of Arora [10, 11, 12, 13] to study the type of materials developed for this stage of schooling in India.

It is clear that there were some very good reasons and motivations for introducing the so-called modern mathematics curricula in the schools. However, in doing so, we seem to have been too ambitious and thus have overshot the mark. We agree that mathematics must form an integral part of one's schooling. But every student does not require the same range and extent of mathematics. We must distinguish between the needs of a small minority of future scientists and mathematicians and a vast majority of the rest. And, above all, for any curriculum to be 'implementable', we must 'carry' the teacher with us for it is the teacher who is the ultimate 'deliverer'.

Note

1. 'Euclid Must Go', title of a speech given by J. Dieudonné in a seminar on mathematics education at Royaumont, near Paris, in December 1959, sponsored by the OEEC.

References

1. KLINE, M. *Why Johnny Can't Add.* New York, Vintage Books, 1974.
2. WILLOUGHBY, S. *Contemporary Teaching of Secondary School Mathematics.* New York, John Wiley & Sons, 1967.
3. FREUDENTHAL, H. (ed.). *Change in Mathematics Education since the Late 1950's: Ideas and Realization. An ICMI Report.* D. Reidel Publishing Company, 1978.
4. *Mathematics in India: Meeting the Challenge. Proceedings of the Conference on Mathematics Education and Research, Bangalore, June 4–15, 1973.*
5. *Curriculum for the Ten-year School—an Approach Paper.* New Delhi, National Council of Educational Research and Training, 1975.
6. ARORA, Manmohan S.; SAXENA, R. C.; CHANDRA, Ishwar. *Mathematics for Primary Schools, Book I.* New Delhi, National Council of Educational Research and Training, 1978.
7. ARORA, Manmohan S. (ed.). *Mathematics for Middle Schools, Book I.* New Delhi, National Council of Educational Research and Training, 1977.
8. ARORA, Manmohan S.; PASSI, I. B. S.; *Mathematics for Middle Schools, Book II, Part I.* New Delhi, National Council of Educational Research and Training, 1978.
9. SINGH, U. N.; ARORA, Manmohan S. (eds.). *Mathematics. A Textbook for Secondary Schools, Part I. 2nd ed.* New Delhi, S. Chand & Company Ltd, 1977.
10. ARORA, Manmohan S. (ed.). *Mathematics. A Textbook for Secondary Schools, Part II. 2nd ed.* New Delhi, National Council of Educational Research and Training, 1978.
11. —— *A Textbook of Mathematics for Classes XI–XII, Book I.* New Delhi, National Council of Educational Research and Training, 1978.
12. —— *A Textbook of Mathematics for Classes XI–XII, Book III.* New Delhi, National Council of Educational Research and Training, 1978.
13. —— *A Textbook of Mathematics for Classes XI–XII, Book IV.* New Delhi, National Council of Educational Research and Training, 1978.

Trends and cases

Teaching: the problem-solving approach

Shalva Amonashvili

As far back as the late 1940s and early 1950s, the Soviet Union began experimenting with a view to devising new teaching methods, and educational psychologists explored a variety of avenues designed to promote the pupil's all-around development.

A long-term view of the evolution of Soviet society requires a scientific projection of the school of the future. A large number of scientific teams and laboratories are working on this question, including the Laboratory of Experimental Didactics of the Y. S. Gogebashvili Scientific Research Institute of Pedagogical Sciences, Ministry of Education of the Georgian SSR. The experimental system used in this laboratory for teaching in the lower forms is based on the problem-solving approach, in which the efforts of the pupils themselves play a paramount role. The problem-solving approach to teaching is founded on the concept of the personality as a whole. The primary element in the make-up of the individual is not only the knowledge he acquires in the course of his various activities, it is above all his needs and motivation. The motivation for study develops during the educational process, in the course of the pupil's scholastic activity. However, the question also arises here as to what the educational process should be and the kind of scholastic activities the young child should engage in so as to develop to the full his motivation for cognitive activity.

A critique of the system of marks

Research on the subject shows that from a very early age a child demonstrates considerable curiosity and cognitive activity; they may be considered as genetically inherent in the child. The school provides a sense of purpose to the child's aspirations, offering him certain subject-matter and study disciplines which make up the content of his learning activity. And if his learning becomes a process giving shape to his cognitive interests, the child will study willingly. His personal motivation becomes an incentive to study: his interest, a positive attitude to the learning process *per se*, 'the joy of discovery', the surmounting of difficulties will all combine to give sharper delineation to the personality of the schoolchild. His scholastic performance will not be governed by the usual system of marks, which in traditional teaching methods replaces the pursuit of knowledge as motivation for study, and as a result of the social importance attached to marks becomes a factor of pressure; it will be governed instead by a form of assessment or evaluation which measures the child's progress in solving problems, in relation to standard (models) responses.

Education based on the problem-solving approach is sometimes called education without marks. However, the idea of the experiment is

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not so much to come up with teaching methods dispensing with marks as to develop in the young schoolchild personal qualities, incentives for study, in which evaluation, exercises and assessments fulfil a regulating function.

It is important, before going any further, to delimit the concepts of 'evaluation' and 'marks'. Evaluation as a component of scholastic activity is construed by us as cognitive activity having a specific purpose. It seeks to analyse the subject, the result of an activity, the course of a completed or proposed activity on the basis of specific models taken as standards. In the evaluation process, the schoolchild acquires new experience, perfects methods for reaching his objectives, avoids mistakes or corrects them in time.

Evaluation as an essential component of scholastic activity does not wind up the process, it accompanies it at all stages. It comes into play especially when there is a need to ascertain the correctness of completed or impending concrete intellectual and practical operations and the results of such operations. By comparing them with standard (model) responses, the learner obtains meaningful information as to the correctness or incorrectness of his actions. The result of this evaluation determines the future course of his learning activity, adjusts it as required and indicates whether he is ready to go on to the next step.

In traditional teaching methods, the evaluation faculty in the younger schoolchild is very weakly developed. We might attribute this fact to difficulties due to age characteristics. But the fact of the matter is that traditional education excludes the evaluation factor from the whole structure of learning activity; the student from the outset is relieved of this type of responsibility which is left entirely to the teacher. The teacher imparts knowledge, checks on whether it has been grasped, records achievements and inadequacies, locates mistakes and assesses the results of learning activity without endeavouring to analyse its actual course. The end result of all the aforementioned operations (at times divorced from one another) is the mark, the manifestation of the teacher's will and authority.

Under such conditions, scholastic activity naturally suffers in respect of linearity and becomes less valuable than it should be. The pupil performs an exercise but is incapable of verifying and evaluating it and discovering any errors he may have committed. The younger schoolchildren find it difficult to judge why the teacher gave them this or that mark. And this likewise holds true for students in intermediate and even higher grades.

Usually marks are considered as having a stimulating effect on scholastic performance. However, they can have a negative effect on a learner and shake his confidence in his abilities. Children frequently go after marks not for the sake of knowledge but to maintain and advance their status. This attitude breeds a tendency among younger schoolchildren to overestimate the results of their scholastic achievements and prompts them to resort to unacceptable means of obtaining the marks they want (but do not warrant). Experiments in this connection have shown that 78 per cent of the children in the lower forms leave school every day with a feeling of dissatisfaction because they think the teachers have marked them unfairly. The majority of those who fail to get the marks they hoped for gradually lose faith in their capabilities and become indifferent to the negative appraisals of their teachers.

As far back as 1911, N. N. Krupskaya wrote as follows about the school of the future:

> In schools today everything is done to divide the pupils and not bring them closer together. Marks, competitive examinations—they all cause envy and conceit. Everything is designed to isolate the pupil from his classmates; he is not allowed to ask anything of the child sitting next to him, no assignments requiring combined efforts and collaboration are given to the class. Each child is compelled to think about himself, to give thought to his own personal success. . . . The school of the future must develop in

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> every possible way a feeling of solidarity among children. All kinds of formalism must be eradicated from the schools, there must be no place for compulsion. As a matter of fact, the school of the future must be a free association of learners united in their efforts to forge ahead together in the realm of thought. The teacher in this kind of school would be only an older comrade, rich in knowledge and experience, teaching the students to learn to think for themselves. He would point out examples, methods of acquiring knowledge, he would help them organize combined independent study projects, teach them how to help each other out in the process of studying. Only that kind of school can become a school of solidarity, a school teaching mutual understanding and confidence.

The use of marks as the main criterion of scholastic performance becomes an end in itself and operates in all spheres of the educational process. This state of affairs, however, does not always have a beneficial effect on scholastic performance. It is important for the pupil to get a mark corresponding to the level of his aspirations—his status in the class, in the family, in society depends on it. But since it is the teacher who gives marks, the pupil's prestige depends on him, and this creates a conflictual situation between teacher and learner. And the conflict is aggravated by the fact that the pupil is incapable of objectively evaluating the sanctions taken against him by the teacher.

Analysing the educational process, the Georgian educationist, D. N. Uznadze has written that an educator seeks to realize certain social goals, he is concerned with the future welfare of his students and, consequently, he sacrifices their immediate interests to the interests of the future. But the student manifests individualistic tendencies and his actions are determined by the here and now. The upshot of all this is that a conflict arises between the teacher whose actions are conditioned by a commitment to the future and the student who is interested in the immediate satisfaction of his current needs. Uznadze characterizes this situation as the fundamental tragedy of education. He considers that the goals of education can be achieved only with the elimination of all contradictions between teacher and student and the establishment of a mutual relationship of trust, love and respect.

During the time he was a director of a school (1916), Uznadze put this concept into practice, abolishing marks in all grades. He wrote:

> Because they are the result of an evaluation, marks are subjective and as such always cause misunderstandings between teacher and learner. Moreover the teacher makes his evaluation on the basis of the general nature of the subject and of the future interests of the child. The latter has no understanding of either one or the other and, accordingly, in most cases remains dissatisfied.

In the lowest grades, the conflictual situation is not readily apparent, it arises and develops at first imperceptibly but subsequently manifests itself in a variety of familiar forms. It is reflected in the scholastic performance of the younger children who exhibit signs of severe strain, experience fear, uncertainty, nervousness, confusion. The extent to which different pupils are affected varies and depends on how they respond to specific situations as they develop.

In the light of all that has been said above, we can now formulate the aim of the study: to develop a type of education designed to create a positive attitude to the learning process itself on the basis of an approach in which the child's scholastic activity is checked and regulated by means of evaluation exercises and assessments measuring his progress in solving particular problems.

Organization of the educational experiment

In the organization of our educational experiment based on the problem-solving approach, account was taken of the changed nature of the

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relations between teachers and learners and between parents and the school, as well as changes in methods of presenting study material.

The relationship between teachers and pupils in the learning process was based on the fact that learning activities were organized as joint projects. Special emphasis was placed on efforts by the teacher to develop among the younger pupils the ability to take an independent stand and express their own views about the question under study. Discussions with the teacher were encouraged. The ways in which assignments were given out stimulated the cognitive interests of the child and his desire to shine. For example: 'Would any of you like to tackle these problems—there are some easy ones and some hard ones, too?' 'Tomorrow we begin work on equations; is there anyone who would like to get a headstart on us and then help us to cope with the problem?' 'I don't know whether any of you are capable of discovering the rules for parsing a sentence, but is there anyone who would like to try?' or 'If any of you don't find this poem to his liking, well, choose another one and learn it by heart!'

The pupils received special training in problem-solving methods developing their capacity for independent judgement and action. Of particular importance in this connection was the establishment of standards by which the younger pupils could measure the correctness of their efforts and the results obtained. Depending on the nature of the material being studied, the exercises and the means employed, standards were set for the children in the form of objects, samples, charts, rules. Through using them regularly, the pupils developed a fuller understanding about the models to be emulated.

As part of the teaching process, pupils were called upon as a group to assess the results of various learning activities as well as their actual course. Special exercises were carried out to develop the pupil's faculties for checking his own and others' work, his ability to discover and correct mistakes, to fill in the missing words in a text and justify his choice, to draw up coherent summaries, to analyse and substantiate solutions to problems, to advance and verify hypotheses, to perform the complex intellectual and practical operations connected with the handling of diagrams, etc. The children were given assignments, the object of which was to discover an error, its cause and ways of rectifying it. They also developed the ability to anticipate, i.e. to foresee the outcome of this or that set of operations.

The educational experiment involved various forms of evaluation exercises and assessments on the pupils' part: verifying and evaluating the results of their class-mates' learning activity, reviewing their written work, asking each other questions and assessing the answers, etc. By these means they gradually reached the point where they were able to use the models as the basis for their evaluation exercises and assessments.

For the experimental classes a variety of special aids had been produced—manuals and textbooks, sets of exercises and methodological recommendations, all adapted to the general philosophy of the educational experiment. In all these aids the study material was organized to encourage the practice of the problem-solving approach to classroom work.

A special effort was made to explain to parents and the community the kind of relationship between adults and children that goes with 'education without marks'. The aim was to make parents more interested in the content side of their children's development (as opposed to the formal side, through a marking system): what they studied, what they were strong in, what they were having difficulty with, what they found interesting, what moral and ethical qualities they displayed. Parents were advised, on the basis of actual examples, as to the manner and the direction in which they might orient their children's interests and draw them into productive activities. Their attention was also drawn to possible incentives, associated as closely as possible with the motivation for learning activity, but excluding prizes or constraints for the successful or unsuccessful performance of school-work.

Twice a year (at the end of December and May), both children and parents received written reports containing detailed information on the areas of knowledge the child was deficient in, recommendations for improving skills and work habits, observations on positive character traits which should be developed and negative ones which should be eliminated, etc. The reports were individual and the teacher discussed them in advance with each child. Besides the reports, parents received samples of their children's work in writing, mathematics, needlework and drawing. The children, presumably, would have discussed these subjects with their parents in conversations on their school-work.

We began educational experiments using the problem-solving approach in 1963. Begun as an experimental laboratory (involving one or two classes), it gradually grew into a mass experiment. With the approval of the Ministry of Education of the Georgian SSR, the experiment is now being carried out in nine municipal and rural districts of the Republic and about 5,000 pupils are participating in it.

Some of the results

The results of the application of the problem-solving approach in teaching were measured using various parameters and at different times. The data collected were compared with the results of identical tests carried out in control classes conducted along conventional lines and using marks (five-mark grading system). In every case it turned out that the pupils in experimental classes were more knowledgeable and mature than their counterparts in the control classes.

The survey was based on long-term observation and a series of assignments and tests given in both the experimental and control classes. Previously Soviet psychologists who had done special research on the problem of study motivation had come to the conclusion that among younger schoolchildren the main factor in learning is marks. Marks generate a number of other incentives connected with the child's place in the community. To be more specific, around 46 per cent of pupils in grade III of primary school study because of parental pressure, or because they feel an obligation or responsibility to do so; only 4 per cent are motivated by their studies as such. In grade III it is increasingly common to find that the children feel weighed down by their duties, homework and studies. This state of affairs was borne out by the experiments we carried out in classes using conventional teaching methods.

Pupils in the experimental class participate much more actively in classroom work than those in the control class: in 56 per cent of the cases, the former readily accept work assigned by the teacher, actively contribute to the solving of various problems, participate in discussions, volunteer opinions, answer questions, etc. In the control class, only 17 per cent of the pupils were so inclined. In the control class, 47 per cent of the pupils dropped out of school for a more or less long period of time, whereas in the experimental class this was true of only 15 per cent.

The following is likewise noteworthy: despite the fact that pupils in the control class were often capable of answering the teacher's question or coping with problems presented to them, the majority preferred to say nothing; in the experimental class, the pupils joined actively in the work of the class even when they were not confident that they had the correct answers or that their observations were relevant.

The nature of assignments, problems and questions differed considerably. In the experimental class, the children were expected to decide things for themselves, to make their own judgements, broach questions with a critical eye, engage in evaluation exercises, make conjectures, recommendations, 'discoveries', achieve results; in the control class, they were invited to memorize, repeat, copy, recite, retell, rephrase, write from dictation, etc.

Pupils in the control class preferred to keep quiet because 'if you make a mistake, you get a poor mark'. Those in the experimental class were not afraid to make mistakes, they were eager to explore, discuss things with their classmates, expose their point of view. When pupils in the control class were given the choice of any easy or hard assignment, almost one-half opted for the easy task, to be sure of getting a good mark. They even did so when they were assured that the assignment would not be graded, explaining their action by saying: 'And suppose they change their mind and give a mark!' The only time the majority of pupils in the control class chose the hard assignment was on a second occasion when they were absolutely certain that it would not be marked. In all three parallel instances in the experimental class, almost all pupils chose the hard assignments and explained their choice by saying that 'difficult problems offer a greater challenge'.

In an effort to show the extent to which a child is bound to marks, the following experiment was made: children were asked to choose a number (from 1 to 9) and then explain the reason for their choice. It turned out that pupils in the experimental class named all the numbers, for a variety of reasons: the number 5 (or some other number) because it was their birth date; number 7 because it reminded them of a dancing figure; number 1 because it was the first digit in a set of series; number 9 because it was the largest and was frequently mentioned in stories; and so on. In the control class, practically everyone chose the number 5 because 'five is the best mark', 'I only want to get fives'.

Lastly, data were collected on the factors motivating the choice of friends. Whereas children in the experimental class sought friendship with all or with those who had a good character or who needed help (83 per cent of the children), in the control class 66 per cent of the children sought the friendship of only the top pupils because 'they're good', 'everybody praises them' or 'you can learn good things from them'.

The problem-solving approach to education accelerates the acquisition of knowledge, and develops the children's faculties in a number of directions as well as their intellectual aptitudes. This has made it possible to introduce in the experimental classes a five-day school week, with the duration of classes limited to thirty-five minutes.

The following preliminary conclusions may be drawn from our experiment in this domain which has now lasted for more than fifteen years:

This method of teaching, which aims at regulating the learning activity of children, is highly conducive to the development among younger pupils of a positive attitude towards their studies, the desire for knowledge becoming the factor motivating their scholastic performance.

The problem-solving approach to teaching also requires no external stimuli in the form of marks, prizes or sanctions, all of which are alien to the child's natural inclination to learning; such stimuli may thwart the child's cognitive activity and interests and may become an end in themselves, supplanting learning as the incentive for scholastic activity.

The success of the experiment points to a means of introducing an element of evaluation into the schoolchild's learning activity, i.e. the ability to compare the results of his performance with certain models that have to be assimilated; this entails the special planning of classroom work, using methodological systems adapted to this end.

Lastly, the problem-solving approach to teaching, aimed at regulating learning activity, can help to develop the pupils' positive personal and ethical qualities and creative instincts and build up an objective and conscious attitude towards the world as it really is.

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An example of educational transformation: Venezuela

Gustavo F. J. Cirigliano

The ideas which originated with the French Revolution (liberty and equality) and liberalism (unlimited progress and free trade) made their way into various Latin American countries in the form of ideals at the beginning of the nineteenth century, and were, at least in part, among the factors that contributed to their political independence.

The peoples of Spanish America were eager to have their own governments and begin to live as independent States; they were anxious for an opportunity to play a role in the world and to carry out a historic plan.

In this context, education is seen to be not only a right but also an instrument that will enable people to play a leading part in the independence that is their destiny. Only a people which has enjoyed the benefits of education, making the great cultural and scientific heritage of Western man its own, can keep pace with universal history, and play a significant role in it.

Not all the countries of Latin America have succeeded in carrying out the historic plan which they drew up at the dawning of their potential national independence. Some projects are still uncompleted, some goals not yet attained; in other cases there has been a succession of national historic or political plans (terms which will be used in this article with almost the same meaning).

By a national (historic or political) plan we mean the scenario of the future history that a nation is prepared to act out under the guidance of its leaders or rulers.

In the case of new countries which have only just gained their independence, the parting of the ways will always be in the imagined or proposed future, whereas in countries which have been established for centuries, the roots of the present are supported by the past and deeply embedded in the past, which also, in its time, was a historic plan. Such countries can be guided by a history (of the past), while those without a past act in accordance with a plan (a history of the future).

In Latin America there has been a succession of historic plans: the movement for independence was the first plan for the future; the plan for integration—with varying degrees of autonomy—into the world economy was the second; and today in Latin America there is talk of the plan for continental integration.

Each historic plan has its own type or system of education, which obviously has to be altered as each new plan is introduced. The form of education best suited to the plan for independence was the army of independence, and education was provided by the great teachers Bolívar and San Martín, rather than by the few schools that had been established; the 'school system' was the most appropriate mechanism for the plan of integration into the world economy during the nineteenth century; and

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we can logically infer that the plan for continental integration demands a new kind of education that goes much further that the 'schooling' provided under the previous plan.

If this change does not take place, there will be a disparity between the situation as it really is and an education that continues to prepare the people for a future which has moved into the realm of the past.

The standard of a given educational system should not be judged, as it often is, by its particular type of technology and the degree of modernity of its educational methods; we should rather look at the relation between the educational system and the historic plan that engendered it.

In a word, if we are to assess the worth of a given educational system in Latin America accurately, we must see how it links up with the historic plan of which it is part or which it serves. In this study—which is descriptive rather than critical, because it deals with recent events or even events that are now taking place—we shall refer to innovations in higher education introduced in Venezuela in the last few decades. We shall attempt to show that such innovations are not practicable unless they are in line with the national plan which gives them their direction.

It is indeed extremely interesting to study the changes that have taken place in Venezuelan education. Venezuela is of course enjoying a period of economic prosperity due to the increase in the price of oil, on the one hand, and the internal dynamics of its growth on the other. But it would be a mistake to attribute the innovations in education to this boom alone. Money *per se* cannot get things moving; something more is required before educational changes are made. This something more may well be the existence of a national plan.

Venezuela probably expends more effort than any other Latin-American country on developing and training its human resources—in short, in educating its people. The fact that Venezuela is concentrating its resources on higher education is central to this study; the figures for higher education have soared from 11,513 students in 1958 to 83,499 in 1970,[1] and from 115,462 in 1972 to 254,979 in 1976. In the last four years enrolments in higher education have doubled; a very high percentage of people in the age-group concerned (19–21 per cent) now receive higher education.

This increase will obviously have far-reaching consequences in the short term, as large numbers obtain higher qualifications; and very soon the effects of the transformation of its human resources that Venezuela has undertaken at the higher education level will be clear for all to see.

Assuming that this growth at the top level is the most important aspect of present-day Venezuelan education, we shall consider the elements or components of what might be called a 'model of development of higher education in Venezuela'; they are: experimental universities (for technological autonomy); a Venezuelan university abroad; the Fundayacucho Programme; the university of work at work; the higher-level National Institute for Educational Co-operation (INCE); the plurality of university establishments; and the National Open University.

These elements constitute an operational model which the country is using to transform its human resources effectively so as to attain its aims. These are not the only elements of higher education, but they do symbolize what is new, and they afford evidence of change and innovation in the educational system.

A model of this kind must not be thought of as an isolated entity. It must be seen as a coherent part of a central political plan or national plan, which gives it its purpose and for which it solves problems. The notion of a 'national plan' has been explicitly formulated by Venezuelan political leaders:

> One can conceive of an overall *National Plan* which would embrace the fundamental problems and projects in rationalized form, of the major part of the

> country, and which would, more than anything else, provide evidence of a commitment to effort and concerted action with a view to achieving the great goals of political, economic, and social development. A National Plan which would be a kind of high-level policy commitment on the part of the government and the other fundamental sectors of the country. . . .[2]

This idea also appears in analyses made by students of the education system: 'Education can only be reorganized by means of a National Plan that is not merely theoretical but functional'.[3] As a working hypothesis based on government documents, we may venture to suggest that a Venezuelan National Plan exists; it may be given different emphases under different administrations in different periods, but it has a basic continuity.[4] For the purpose of this study, the National Plan that has been in force in Venezuela for the last few years can be summarized as follows.

A determined move to regain or obtain control of natural resources of vital importance—oil and iron—so as to achieve independent economic development (this move takes the form of specific action as a member of OPEC and also measures to nationalize iron and oil).

To take action such as this requires human resources of the highest quality in the scientific and technological professions. In these professions no importance should be attached to a person's social origins—all should have a real chance to succeed—nor to his country of origin, nor to the way in which he has acquired his knowledge. These are the professions that maintain effective continuity of control of the vital natural resources mentioned above; they make up in quality for what Venezuela lacks in quantity of population compared with her neighbours, and they could constitute valuable human resources even in the post-oil era.

These two actions will be consolidated if Venezuela's international position continues to be strong and vigorous. But it will not be so unless two conditions are fulfilled: it must have the security provided for by Latin-American integration, in which Venezuela has assumed a leading role; and it must have the strength which it would get from taking its rightful place in the world context and working together with the great powers.

Man is to be seen as the protagonist and pivot of these actions; they constitute a historic scenario in which human dignity is all-important, and economic development must be subordinated to it in an ecologically balanced world. The above-mentioned plan would at the same time produce the educational model described below.

Experimental universities

Specialists usually distinguish three periods in the development of university and higher education in Venezuela.[5] The first period—up to 1958—is that of the establishment and development of the traditional universities: Universidad Central de Venezuela (1721), Universidad de Los Andes (1810), Universidad del Zulia (1891), and the first private universities, Universidad Católica Andrés Bello and Universidad Santa María, both founded in 1953.

But in the second period (1958–70) and the third (1970) new methods appear, on the basis of various institutional models which altered the university scene, and different institutional and curricular systems were introduced—experimental universities, polytechnics and experimental teacher training establishments.

The Universidad de Oriente (1958) was the first important experimental innovation:

> The Universidad de Oriente took a regionalized view of education that was quite new at the time, and experimented with new teaching structures and models: basic studies, departments, academic credits, more student aid, close relations with the community, counselling for students whatever their nationality, and extensive programmes to train teachers through post-graduate studies overseas.[6]

It is during the third period that we find advances such as those made by the Universidad de Oriente. Most university colleges, university institutes of technology, polytechnics and teacher training colleges were established in or after 1971. But the attempt to introduce new institutional and curricular structures is probably best exemplified by the so-called experimental universities, among them the Universidad Simón Bolívar (1970), the Universidad Simón Rodríguez and the Universidad Nacional Experimental del Táchira:

> [The first] was established after careful research, and there are several new features in its structure, the technological courses it offers, its curriculum planning and its strict selection criteria for staff and students alike. The Simón Bolívar University was an innovative experiment of great importance in the first half of the seventies, just as the Universidad de Oriente had been in the sixties. The educational principles of the Universidad Simón Rodríguez appear to be extremely advanced, but it has been in existence for only a short time, and there has recently been evidence of important philosophical changes in its outlook, so that it is too soon for us to form an opinion about it.[7]

It is perhaps worth emphasizing that in the case of the experimental universities the explicit aim is to attain a high standard in the scientific and technological professions, in keeping with the postulates of the National Plan. The basic aims of the Universidad Simón Bolívar, besides the aims it has in common with other universities, include the following:

> . . . to contribute to the training of the professionals and technicians required for the country's progress, in accordance with the guidelines laid down in the Development Plan; to experiment with structural systems and with teaching and learning methods which make optimal use of the teachers, ensure that the students get the best possible results, and use the institution's resources and equipment so as to produce the best education possible.[8]

A Venezuelan university abroad

The Gran Mariscal de Ayacucho Fellowship Programme was established by Decree 132 of 4 June 1974. Venezuela literally, not metaphorically, set up a university abroad, and, by sending more than 10,000 young people to be trained in the world's great capitals, established what one might call a university campus abroad.

The main purpose of the fellowships is to train young people of slender means as technicians and professionals; such people are needed if the country is to achieve independent economic development. Two basic principles are observed in the fellowship programme: candidates must be young people of slender means, and they must be training for professions that are of prime importance for development.

By 1974 2,000 fellowships had been awarded, the methods of selection being carefully designed to conform with these two principles; of this number 1,000 studied in Venezuela, 500 in the United States and the rest in various countries, including the United Kingdom. The programme experienced various vicissitudes, with all the drawbacks and difficulties that stem from the ambitious nature of the project, the haste with which it was put into operation and the lack of any previous operational infrastructure. Unesco carried out a survey on this programme during the first two years of its existence, analysing the difficulties, evaluating its achievements and offering suggestions for modifying policies which had not been entirely satisfactory? The report described the programme as 'a project without precedent in Latin America', and attributed its creation not only to Venezuela's burgeoning economy but to the fact that 'it was engendered by patriotic and democratic ideas more than anything else'.

So far 15,000 fellowships in important areas of science and technology have been awarded.

Only 5 per cent of these have been given for studies in arts or the humanities. In 1978, 9,971 students were studying under this programme in more than thirty countries and in institutions of a good standing (most of them, however, are in the United States of America in accordance with the national plan). These students make up another university, a new Venezuelan university, whose main aim is to serve Venezuela, although it is not on Venezuelan soil. To these students must be added the 7,000 fellowship-holders who are furthering their studies in Venezuela. Of this itinerant university population, 2,634 students are engaged on post-graduate work, some of them in Venezuela. In 1977, 800 fellowship-holders graduated; they returned home and set to work to attain the socio-political objective of the programme. In 1978 there were 1,500 graduates so employed, nearly half of whom had completed a post-graduate course.

Fundayacucho, as the programme is called, is an unusual project for training highly qualified staff which has been carried out in Latin America in the last decade. It is probable that too little is known, as yet, in Latin America about this project and its implications.

And if one thinks beyond the present, one can well imagine that when so many people with such varied cultural experience and with advanced scientific and technological qualifications return to their country they are bound to make great changes in the social life of Venezuela in the next decade. The nature of these changes is difficult to predict, but Venezuela will accept them.

All this means that we must be prepared for the qualitative and quantitative impact of this enormous mass of human resources. Of course, there will be a price to pay. Moreover, criticisms have already been levelled at the programme:

> There are still élitist groups in Venezuelan society who find it hard to accept the fact that lads from Bobures, Achaguas, Delta Amacuro and other places in the interior, who would never have had the chance to go abroad can do so under this extraordinary plan. This will lead to tremendous upheavals in Venezuelan society and will be a new factor in social advancement.[10]

A national project always generates its own type of person, and Venezuela is producing a new type of person to carry out its project. This change is being wrought by determined action and on an enormous scale. And so a whole city will witness the return of an immense army that is poised for change, an army of people who have seen other horizons, had other experiences, observed things from a different angle and, for a time, held quite another view of the world and of life. There is no doubt that when the bulk of the army of Fundayacucho students return, they will bring about many changes in the country, and that is precisely what the country is hoping for. The situation is not without precedent: during the colonial era many promising young South Americans were sent away to the mother country to further their studies, and these same young men, when they returned, achieved the political independence, which South Americans longed for, accomplishing exactly what their countries hoped they would. Ten thousand young Venezuelans throughout the world are obtaining scientific knowledge and technological experience of a very high order. This will not only change things in Venezuela; it will also exert a decisive influence on the future of Latin America. And so we bring to a close these thoughts on this particular component of the model which is designed to bring about unprecedented changes in the people and to produce the human resources by means of whom the plan's main objectives—economic independence at the service of man—can be attained.

Lastly, we should add that this component of the educational model, like the one mentioned earlier, is characterized by diversification and plurality. It has not been confined to one country; on the contrary, it is supported by thirty countries, which offer a wide range of experience in the scientific, political and social fields and in that of life itself.[11]

University of work at work

The idea of the higher-level INCE was first mooted on 11 September 1976, the date on which some countries in Latin America celebrate the Day of the Teacher. The scheme was put forward in broad outline, and details had to be filled in and the practical implications worked out in the course of time.

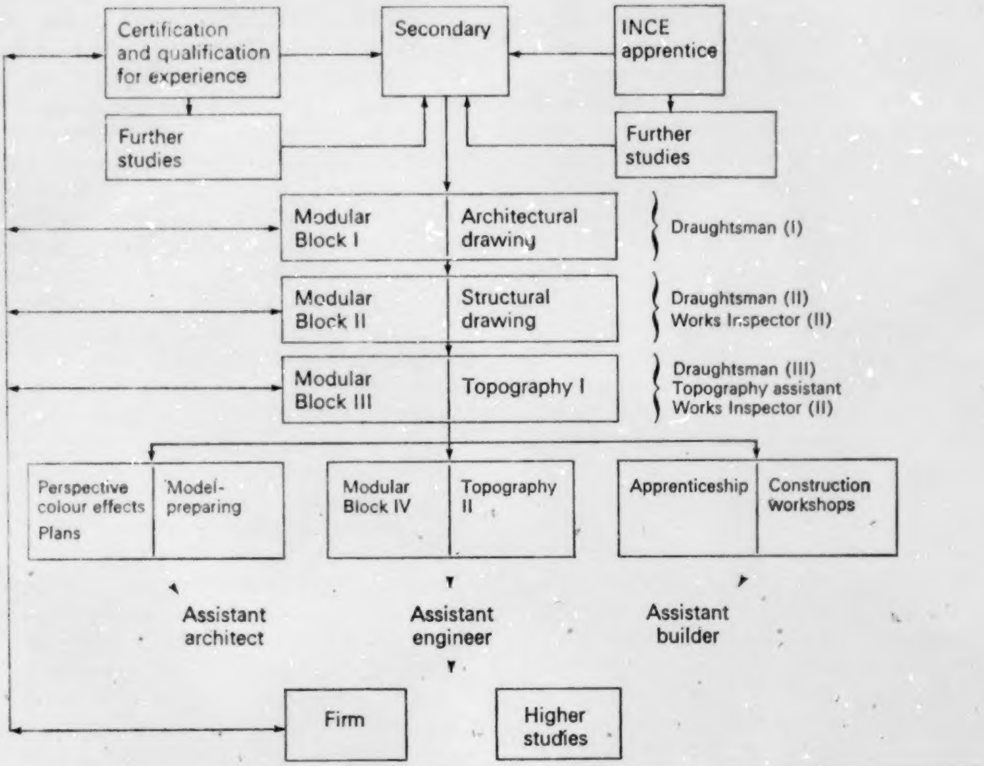
The National Institute for Educational Co-operation (INCE) like other bodies that train workers, e.g. the SENAI in Brazil and the COMET in Argentina, has done valuable work for the provision of technical and industrial training. A new feature of the higher-level INCE is its action at the tertiary level, in higher (post-secondary) education—on which the emphasis was placed in the Venezuelan national plan when its operational model was elaborated. What form will such action take in practice?

The higher-level INCE will offer courses for three different sectors of the population: ordinary school leavers who have obtained the *bachillero* (leaving certificate), those who have completed INCE's own courses (apprentices, in other words) who are employed in a job and workers. It should be noted that the plan provides for recognition of the experience and knowledge that members of the latter group have acquired through their work; credit is given for such knowledge, and it is accepted as part of the courses, which are organized in units of work.

The higher-level INCE is not intended to compete with ordinary universities although it offers alternative courses to holders of the school leaving certificate) but rather delimits its own field of activity. So while it gives the holder of a leaving certificate a chance to enter the technical, entrepreneurial or industrial field, it also offers workers and those who have completed the INCE course (apprentices) an opportunity to undertake further studies, so that they can reach a level equivalent to that of the school leaving certificate (see 'Entry', Fig. 1). The worker's experience is counted as part of these studies.

Last year, the higher-level INCE introduced short higher education courses lasting one or two years. These courses, as the way in which they are referred to shows, provide training for an occupation rather than give the student a mass of academic information. (They will produce a manager or a draughtsman rather than a graduate.) The idea is that every course should naturally lead on to a more advanced one; for example, a stretcher-bearer should be able to become a doctor. This system will enable INCE graduates to take their place in the formal education system—as shown in Figure 1—once they have completed the short course.

A system of modular blocks has been adopted to ensure that proper recognition is given to the knowledge the student possesses. No terminal courses are offered, so that the alternative of work or employment is always open to the student, regardless of the level (complete block) he has reached. Each block mastered and 'recognized' gives the student a certificate which effectively qualifies him for an occupation. If a special study or short course comprises thirty work units, and the worker already has twelve of these as a result of this work experience, INCE recognizes them and gives him an opportunity to do the remaining ones, which will bring him up to the required number. In the figure a student who finishes Block I becomes a draughtsman, while if he finishes Block II he becomes a draughtsman (II) or works inspector. These are names of real occupations rather than qualifications. In traditional universities people study subjects; here they learn a job, they acquire practical knowledge for use in an occupation. As we have said, the courses are



Entry and leaving—higher-level INCE

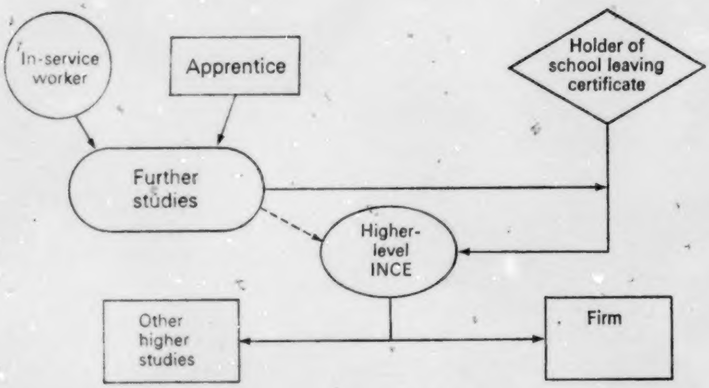


FIG. 1. Modular system of training young people who will be entering the higher-level INCE.

referred to by the name of the jobs as they really are—for example, 'accounts manager'.

In accordance with the view that work should be recognized as imparting knowledge, the following courses were offered as from 1978: building, administration, secretarial studies, design, accountancy and industrial trades (mechanics, electrical engineering, etc.). In April 1978, the Caracas daily papers announced that the higher-level INCE was to begin its activities, offering holders of the school leaving certificate—who were urged to specialize in some field of higher education—courses leading to the following careers: computer programmer, computer systems analyst, administrative secretary, assistant auditor, budget assistant, assistant financial analyst.

In this way it is hoped to attain the level of technological training which is essential if high standards of production are to be reached. A university provides professional training aimed at intellectual development, but the goal of the higher-level INCE is 'technological training geared to productivity'. This objective is clearly in keeping with the idea of a national plan designed to attain the highest possible standards in science and technology, with a view to gaining absolute control of the key economic resources and their technological processing.

The higher-level INCE can be described as a new university which starts from work as a basis for learning and culminates in work as it exists in reality, offering the possibility of a career and personal fulfilment, in the context of the priorities of development to which the country's national plan is geared.

The plurality of university establishments

We have said that one of the elements of the national plan is plurality, or the diversification of the function of training human resources. There are many forms of higher or further education in Venezuela, and though it may be thought that such variety would lead to chaos the main object—to train human resources in science and technology—is borne in mind, and priority is given to such training. It is generally agreed that there should be more than one road to this goal.

The university institutes of technology, polytechnics, training colleges and university colleges, which have expanded considerably since 1971, are indicative of an attempt to diversify institutional structures or models in order to reach the highest possible standards of science and technology at all levels, for the good of the people of Venezuela. The aim is to reach the level of human resources required for independent development as quickly as possible. Various means are used to achieve this aim, and sometimes one has the impression that there is a certain amount of overlapping.

There are five university colleges of education; only two existed prior to 1971. There are four university polytechnics, which train engineers in fields directly linked to production. Venezuela has nine university institutes of technology, which offer short courses for experts in areas vital to the country's industrial development; these were all set up after 1971. There are six university colleges that train specialists in administration and in education, who may either begin to practise their profession immediately or continue their studies at a higher level; all these were established after 1971. Apart from these there are fifteen private university colleges or institutes. It is clear, therefore, that higher or university education is indeed heterogeneous.

The President of the Republic declared in July 1978 that there were seventy-one university institutions in the country—a very considerable increase since 1958, when there were only six.

This diversification, however, is not the result of chance, sudden inspiration or improvisation. It is, rather, one of the exigencies of the central historical plan and of the need to train a certain type of person if development is to be achieved. The university documents are quite specific and clearly stipulate that the country's development plans necessitate training people in the following priority areas: hydrocarbons, chemistry, petrochemistry, metallurgy, electronics and telecommunications, agriculture, food technology, marine resources, health, education, nutrition, town-planning, capital goods, ecology and energy.

In connection with the question of diversification to conform with the values of the national plan, we should mention—though it does not properly belong to the sphere of higher education—the joint INCE/Ministry of Education programme, under which more than 5,000 reservists (a small army for the battle of technology) have been sent to Spain to learn trades as apprentices.

There is also another system at higher and university level which constitutes a sort of combination of the many variations and innovations. It is the National Programme of Assistantship in Industry, which was established in 1976 and is mandatory for all firms. The number of assistantships of this sort now held is estimated at 9,000. The programme is executed by the Education–Industry Foundation (FUNDEI), the Ministry of Education and other bodies. It enables students to continue their course while actually working in industry, under the supervision of the firms and the educational centres to which they are attached. Firms are asked to take an active part in the students' work, so that their studies will not be cut off from their work.

The assistantship covers six weeks' full-time work, and the firms' working hours are observed. It is designed for students in their last semester at university colleges or institutes of technology, in the priority areas mentioned above, and also for students specializing in industrial subjects at teacher training colleges and students of university polytechnics and universities; in this last case, enrolment depends on the applicant's speciality, and the student must be in his fourth year. (An assistantship programme for students in their final year of secondary school is under consideration.)

It will be seen that this last programme has the following characteristics: simultaneity of study and work, heterogeneity of the roads to learning observance of the development priorities laid down by the national plan and vigorous promotion of higher education.

The question may arise whether such efforts in higher education might not lead to a surfeit of highly trained personnel. The answer is that the country is trying to make up in quality for what it lacks in quantity, once the immediate requirements in human resources are met; for Venezuela has a small population compared with her neighbours. A country that has an abundance of natural resources in world-wide demand, coupled with a small population, needs to see that its people are highly qualified.

The Universidad Nacional Abierta—UNA (National Open University)

The UNA was established in 1977, but had been in the planning stage since its Organizing Committee was set up in 1975. In September 1976 the LACFEP Conference (Latin-American and Caribbean Conference on new forms of post-secondary education) was held in Caracas. During the closing sessions of the conference two documents on the structure and character of the UNA were submitted for the delegates' consideration. It should be mentioned that the conference had earlier analysed more than fifteen experiments in non-formal, non-school open education, including innovations ranging from the Open University of Great Britain and Spain's Universidad de Educación a Distancia (University of Distance Education) to the University without Walls in the United States, to name but a few. At the end of the conference the delegates approved the new idea, which was put into effect a year later.

The UNA is a higher educational institution which trains professionals in priority areas for national development; the system of open education and distance education is used, and modern methods of mass communication are employed. Features of the national plan, such as the identification of priority areas and the emphasis on higher education, can be observed in the UNA. At the same time, the open method itself is entirely consistent with the heterogeneity and multiplicity we have mentioned.

The potential student body of the UNA consists of young people and adults who, generally for reasons connected with their work, have been unable to attend the traditional universities. The UNA student could be considered as a 'working adult'.

The work of the UNA is based upon three principles: education as a means of *democratization* (to this end, it embraces a wide field, both geographically and socially); education for *independent development* (it therefore trains people who, through science and technology, will provide solutions to the nation's problems); education for *innovation*. (In this field Venezuela is in the vanguard of Latin-American nations, in that it has introduced a new educational methodology—distance education—and a new teaching technology.)

The UNA considers its action from three standpoints, which are in line with the process of independent development: the *instrumental* standpoint, to which the criterion of effectiveness is applied, and whose object is the effective achievement of the objectives in the time allotted and with the means decided on; the *economic* standpoint, to which the criterion of efficiency is applied, and whose purpose is to ensure that the objectives attained are commensurate with the effort expended and the resources used; and the *social* standpoint, to which the criterion of relevance is applied; it is involved because the results achieved are related to the social milieu. The first standpoint means that a working adult can receive an education by new methods; by these same methods the second makes it possible to cut costs; while the third is aimed at the actual transformation of the existing state of affairs and the actual integration of knowledge into the social environment.[11]

The student learns by using specially designed self-teaching equipment, the internal structure of which is suited to the student's abilities; and the final result of this interaction is learning. The material includes a statement of the objectives, the units of information relating to them and an initial test, with answers supplied; the information is then developed, and there is a test at the end. Although printed material predominates at first, other methods such as television films and radio are also used. The students can also get help from guidance officers and academic advisers (or tutors) at the twenty local centres where they obtain their supplies, sort out any problems they may have and hand in their examination papers. (See Fig. 2.)

Details of the material to be taught are set out in accordance with a plan (Table 1), which enables the students to understand what their aims must be, organize their time to suit their own learning pace, improve their knowledge by following the instructions accompanying the self-teaching material, and test themselves so that they can see to what extent they have reached their objectives.

The UNA is headed by a Council and governed by a Board of Administration comprising the rector, the academic and administrative vice-rectors and the university secretary. To start with it has been organized in programmes and sub-programmes which are linked up with systems and sub-systems. Time will tell whether the structure adopted should be maintained or whether it will have to be modified, for the whole scheme is still at the experimental stage.

The academic structure of the UNA comprises five broad fields of study, within which

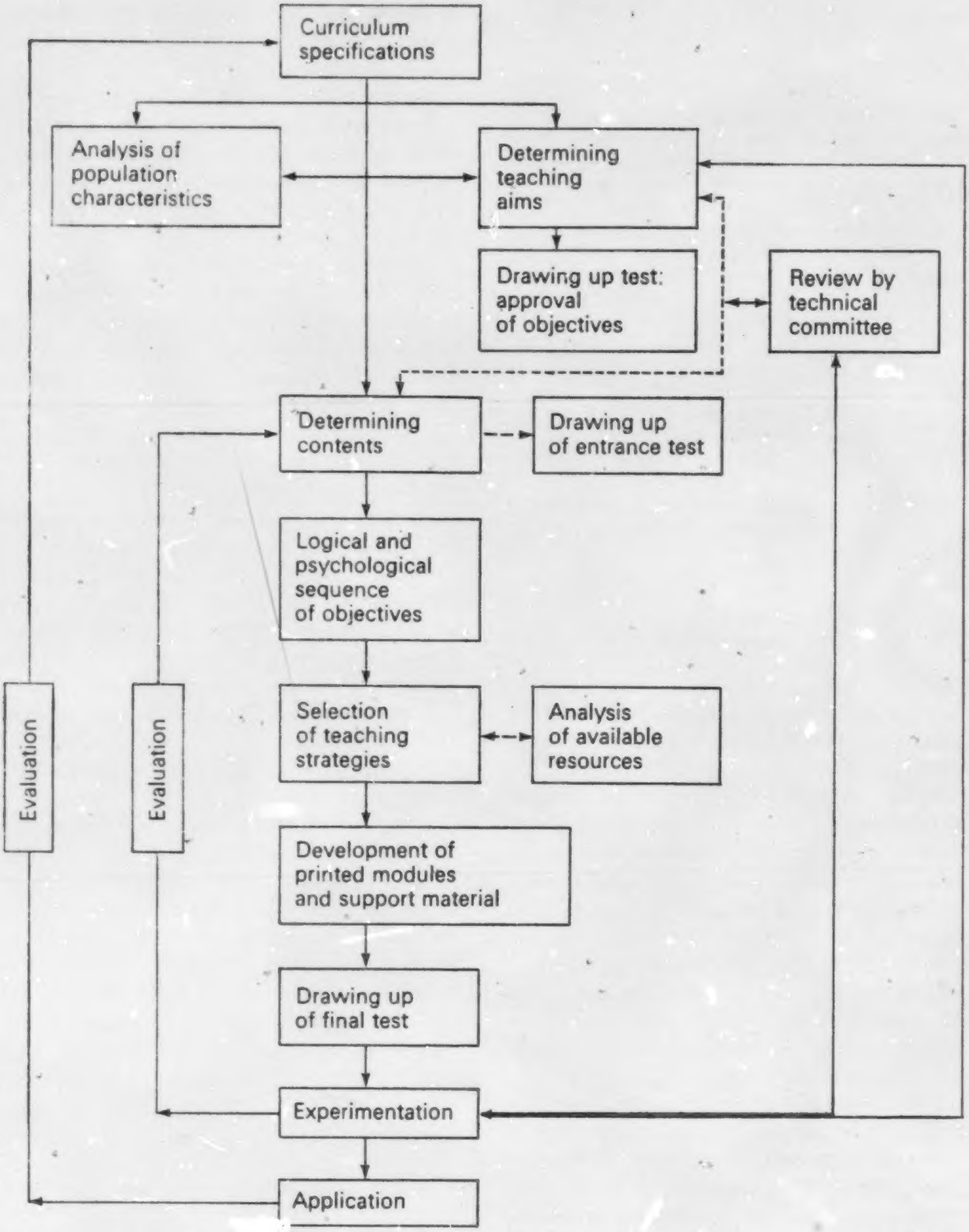

Curriculum specifications
Analysis of population characteristics
Determining teaching aims
Drawing up test: approval of objectives
Review by technical committee
Determining contents
Drawing up of entrance test
Logical and psychological sequence of objectives
Selection of teaching strategies
Analysis of available resources
Development of printed modules and support material
Drawing up of final test
Experimentation
Application
Evaluation
Evaluation

FIG. 2. Model for UNA teaching outline.

TABLE 1

Field of study	Professional training
General Studies	Common to all courses
Basic Sciences	*Degree in Mathematics*
	Degree in Physics
Engineering	*Industrial Engineering*
	Systems Engineering
	Environmental Engineering
	Civil Engineering
Education	Degree in Education with specialized study of the following:
	Technical Education
	Physics
	Mathematics
	Languages
	Social Science
	Pre-school Education
	Special Education
Social Science	*Degree in Public Administration*
	Degree in Business Administration
	Accountancy
	Degree in Sociology (rural or industrial)
	Degree in Social Work

various professional courses can be taken. (The courses to be offered at the outset are printed in italics.)

It may seem strange that an Open University should offer professional courses, especially from its inception. But it does so because it is geared to the national plan, which needs workers in the scientific and technical professions. This does not mean that it will necessarily emphasize professional courses later on. In future there will be an 'open' curriculum which will enable the student to compile his own curriculum, choose his own subjects and decide whether to take a professional course or not.

In future, too, when certain restrictions imposed by the regulations now in force can be removed by the new law on higher education, people who have not completed their secondary education will be able to enter the university—a possibility which is in keeping with the spirit of the UNA. There is also a plan afoot to introduce short courses at third-year level and also post-graduate courses.

What is original about the foundation of the UNA is the fact that it is an attempt to generalize or universalize an innovation so that it becomes the seed of a future educational system. Tests and experiments usually work when they are applied over a limited area only, but not always when the principle is applied more generally. The UNA is ready to accept this challenge on behalf of Latin America; it is prepared to take bold measures and move on from the experimental stage to a wider area of operation. Some universities have an open department which provides distance teaching for 200 or 300 students, but the UNA started out with 17,350 students from all over the country. Because it is experimental in nature it requires large numbers if it is to make any impact.

Having analysed some of the components of the model of higher education in Venezuela, we can arrive at certain tentative conclusions:

It would appear that the genuine transformation and renovation of educational systems cannot come about in isolation; they must be part of a national plan.

Future changes may be related to out-of-school methods.

It would seem that there may be a multiplicity of paths to learning.

Today, Venezuela can be considered more or less as the laboratory in which experiments on the viability of Latin American education in the future are being carried out. Whatever is viable in the future will certainly contain elements which are now being tested by the Venezuelan experiment.

Notes

1. Miguel Casas Armengol, 'Apuntes sobre la Evolución de la Educación Superior en Venezuela', *Papeles Universitarios* (Caracas), No. 4, November–December, 1977, p. 114.

2. Luis M. Peñalver, speech given at the Extraordinary Session of Congress, 5 July 1977, Caracas.
3. CERPE, 'Una Educación para Venezuela', *SIC* (Caracas), No. 400, December 1977, p. 485.
4. In a document published for the School of Education of the Central University of Venezuela, in 1978, entitled *Sobre el Modelo de Desarrollo en la Venezuela Actual* [On the Model of Development in Present-day Venezuela], Jorge Linares, Lenín Romero and Lautaro Videla point out the following components of the Venezuelan national plan: (a) nationalization of industries producing basic commodities; (b) reform of the State structure, enabling the State to act as an entrepreneur; (c) the establishment of a mixed economy; (d) export of industrial products; (e) agricultural transformation; (f) a new kind of man for the new plan; (g) nationalism; and (h) influence on neighbouring countries.
5. Casas Armengol, op. cit.
6. ibid., p. 114.
7. ibid., p. 115.
8. *Final Report: Higher Educational Planning. Annex: Characteristics and Objectives of Higher Educational Institutions in Venezuela*, Vol. 6, p. 33, Caracas, 1975 (mimeo.).
9. See the Sadosky Report on the Ayacucho Plan in *Papeles Universitarios* (Caracas), No. 3, October 1977, p. 116.
10. From a press conference given by Professor Ruth Lerner de Almea, Chairman of Fundayacucho, on 10 August 1977.
11. No less bold and comprehensive is the suggestion made by the Venezuelan Ambassador to Spain, who has given his support to the creation of the OPEC (Organization of Petroleum Exporting Countries) University, with the aim of training human resources in order to facilitate the development of Third World countries by capitalizing on the remarkable opportunity for transformation offered by resources derived from oil, which should not be merely used or squandered.
12. UNA Organizing Committee, *UNA—Plan*, Caracas, 1977, 138 p.

Book reviews

Pierre Erny, *L'Enseignement dans les Pays Pauvres. Modèles et Positions* [Education in the Poor Countries. Models and Positions], Paris, L'Harmattan, 1977.

Pierre Erny, with his considerable experience of education in Africa (he started as a primary school teacher in Upper Volta before becoming a university professor in Zaire and Rwanda), gives us in this book the essence of his thinking on current educational problems in Africa and, indeed, in all countries with limited resources which are today confronting the apparently insoluble problems caused by unsuitable school systems.

The author begins by enumerating recent attempts to renew education in various African countries, with particular reference to efforts to 'ruralize' education. The examples he chooses illustrate the ambiguity of the concept, but also its absolute necessity. It is ambiguous because it continues to be seen as the 'instinct for self-preservation of a ruling neo-bourgeoisie uncertain of its future' (p. 68) or 'an approach adopted by town-dwellers to country people' (p. 70), who have no difficulty in seeing what really lies behind it. But it is also a necessity if schools are not to continue adding to the ranks of those whom Emmanuel Mounier, as early as 1947, was calling 'the half-taught, with neither hearth nor home, living among the empty shells of words' (p. 65).

The name must therefore be changed, while the work is continued, and Erny subjects to lucid analysis both the reasons for failure and the conditions to be met to ensure the success of a transformation now more necessary than ever. Among the reasons for failure, apart from the political ambiguity to which attention has already been drawn, Erny rightly stresses the shortcomings of teacher training ('a ruralized system of education', he writes, 'calls for a teaching staff with indisputable teaching, agricultural and technical qualifications, which teachers trained in the ordinary way have never had' (p. 69), the lack of liaison between educational project and rural development project ('the basis for ruralization is the development of the rural economy. The transformation of agriculture will give education its real meaning, and not the reverse' (p. 70)), and, in a strictly educational context, the fact that environmental studies are not linked to practical agricultural work. The pages he devotes to environmental studies, both in the chapter on ruralization and in the last two chapters of suggestions, seemed to us to be among the most instructive in the book, and undoubtedly contain passages which should henceforth be included in all teacher-training college libraries.

After this analysis of efforts to renew the African school, Pierre Erny turns to three other experiments in the transformation of education systems (in Peru, Cuba and China), not to copy them, he writes, but 'to show what is possible and to stimulate the imagination' (p. 7). From this panorama of experience, to which he adds that of the *maisons familiales rurales* in France, Pierre Erny draws four main conclusions.

The first is that school is not, or should not be, the only source of education. 'It is not a question', he writes, 'of doing away with schools, but of making use of all the available educational resources' (p. 95). The logical corollary is that teachers are not the only repositories of knowledge and that the school should take advantage to a very large extent of all the human resources present in the area.

The second conclusion is that if school is to be linked to life, then it must be diverse, just as life itself is diverse. Within the general framework of standards set by the State, a very large degree of freedom must be left to the regions to define the most appropriate ways of achieving the ultimate objectives.

Third conclusion: the combination of study with productive work must be one of the keys to the new teaching. On this point P. Erny concurs with a number of the conclusions presented in one of our 'Dossiers'.[1]

Last conclusion: a new type of school must be invented which will no longer be 'a major cause of social differentiation', but a school for the advancement of the whole community. Rooted in its environment, writes Erny, the school should goad it into action by promoting self-awareness and help to instil a continuing need for change. Creating close links between training, education and development, it should become one of the bodies that makes the community conscious of its values and its shortcomings and ready to assume responsibility for its own future (p. 98).

These are Pierre Erny's main suggestions, set out in his last chapter to form a teaching project that is innovative and at the same time realistic.

But two things will be missed. We feel that his demonstration would have been strengthened if it had been applied to a specific country (for example Rwanda, where he lived for a long time). And we might also have expected a specialist in the anthropology of education[2] to devote more space to traditional education and in particular young people's associations. But perhaps these two points are left for another occasion.

GUY BELLONCLE

Notes

1. 'Learning to Work: School and Production', *Prospects*, Vol. VII, No. 3, 1977.
2. cf. *L'Enfant et son Milieu en Afrique Noire. Essais sur l'Éducation Traditionnelle* [The Child and His Environment in Black Africa. Essays on Traditional Education], Paris, Payot, 1972.

Maurice Debesse and Gaston Mialaret, *Traité des Sciences Pédagogiques*. Vol. 8: *Éducation Permanente et Animation Socio-culturelle*, Paris, PUF, 1978.

Gaston Pineau, *Éducation ou Aliénation Permanente?* Paris, Dunod; Montreal, Sciences et Culture, 1978.

Lifelong education is in a paradoxical situation. On the one hand, the term has met with astonishing success and in the space of a few years has gone right round the world. Nowadays it would be hard to find a politician, administrator or theorist concerned with education who has not referred, at one time or another, to the idea of lifelong learning. By 1975, over 5,000 documents, books or periodicals dealing directly with this concept had already been listed. This cannot fail to please those who see in lifelong education the necessary alternative to the dead ends and inadequacies of the education system as designed and organized in most countries.

At the same time, however, approval of the concept has been qualified by many reservations and serious doubts. Even if we disregard the opposition of the advocates of tradition and their anxieties about repercussions and consequences, we are still faced with two major problems. The first is the contradiction between words and deeds. After fifteen years of proclamations and solemn pronouncements, we are forced to admit that the panorama of education as a whole has scarcely changed. The traditional model of education, which is dominated by the principle of selection and knows nothing of the diversity and complexity of individual potentialities, continues to prevail, with its concomitants of examinations and degrees serving to winnow the chaff from the wheat and resulting in the advancement of people who are able to adapt to the norm and the marginalization of others who are less gifted or do not conform.

The second problem is the variety of ways in which the term is interpreted. Some see in lifelong education the possibility of applying a principle of renovation to the whole educational process from infancy to old age. They know that this is a long-term project and implies a sustained effort to conduct both theoretical and practical research work. Then there are those who are accustomed, in their activities, to applying the term 'lifelong education' to one particular stage in the educational process, namely the one which concerns adults. It is even apparent, from a glance at many of the programmes, that the term is most commonly understood to refer simply to retraining for occupational purposes.

This confusion, which is regrettable at the theoretical level and dangerous at the practical level, will not be dispelled by the eighth volume of the *Traité des Sciences Pédagogiques* published under the direction of Maurice Debesse and Gaston Mialaret. The very title of the book—*Éducation Permanente et Animation Socio-culturelle*—is misleading. The reader can only be surprised to find that the whole and the part are placed on the same plane; a broad concept ('lifelong education'), which has the most far-reaching implications both as regards its comprehension and as regards its world-wide application, is presented side by side with an expression ('socio-cultural promotion work') which is understandable only in one particular context, that of France and a few countries influenced by French models.

The contradiction is evident even in the structure of the book. The first chapter gives expression to the writer's concern to look more closely at the theoretical implications of the concept, which it sets in the context of the view that education is a continuous and uninterrupted process. But when the reader comes to the second chapter he finds that the expected investigation has already been laid aside and he is thrown into the small world of adult education, presented from the angle of occupational advancement.

The next chapter—'Psychological Aspects of Lifelong Education'—interesting though it is in itself, is slanted even more definitely in this direction. The subtitles—'The Adult Student Image', 'The Adult and His Times'—indicate that the individuals with whom the writer is concerned are those who have already embarked on their adult life, and that the themes announced at the beginning of the book have been abandoned.

Thus the inquiry is limited, in fact, to one phase of life. This is really just as well, because the concept of lifelong education, as truly and fully understood, has not yet been developed through theoretical studies and practical experience to the point at which it can be regarded as ripe for presentation in the form of a treatise. The work is still at the stage of hypothesis, research, investigation, confrontation of points of view, debate, experiment, and it is too early to produce a synthesis and a general picture of the situation.

In this particular context, the publication of the book assumes great significance. It is a landmark in the evolution of educational thinking in France. Not so very long ago adult education was still being spoken of in France as the 'poor relation' of education. Poor it certainly was as regards its scope, for it involved only a small fraction of the population. But it was also poor in the literal sense, inasmuch as it was allocated only a tiny fraction of public and private funds. The situation has radically changed during the last ten years, mainly because of the legislative measures which have speeded up the educational process in the field of vocational training. Since the law on lifelong education was passed in 1971, the number of people benefiting from this type of education has multiplied by ten, and its budgetary and other resources have increased in similar proportions. Although much remains to be done before this aspect of national activity wins its rightful place, so that its range is extended beyond the strictly occupational field to embrace the whole personality, adult education is now firmly established at both the theoretical and the factual levels. This progress is confirmed by the publication of the book under review.

The editors have called upon particularly well qualified contributors. Mr Antoine Léon has covered the psychological aspect. Mr Jean Vial has dealt with the sociological aspects and with adult literacy. Mr Schwartz and Mr Scheffknecht have jointly conducted an admirable review of 'continuing training for adults'. The director of the *Traité*, Mr Mialaret, has devoted a chapter to one specific project, namely the TEVEC programme in Quebec, a multi-media experiment in adult education.

Each chapter of the book provides a mass of information which should be very useful to everyone who needs to keep in touch with what is going on in France. It is a pity, however, that a work entitled 'Survey of Educational Sciences' should pay so little attention to experiments carried out elsewhere. Whole chapters have been written without making the slightest reference to what is happening in the United Kingdom, the Federal Republic of Germany, Scandinavia or the United States. This probably limits the 'scientific' usefulness of the book, especially in a field where, in contrast to the situation prevailing in respect of the education of children and adolescents, diversity and individuality are the keynotes. Here, even more than in other fields, it is essential, in order to grasp a problem and reflect on its implications, to collect and compare information about the experiments undertaken in different types of civilization and culture.

The most original, and therefore the most interesting part of the book, deals with socio-cultural promotion work. The reservations expressed above do not apply to this part, especially as the authors 'show their hand' quite frankly: they are concerned with the work of this kind that is being done in France. It is a field in which French educationists have undoubtedly played a pioneering role as regards both aims and methods. What is meant by 'promotion work' in this context? Each of the specialists responsible for this part of the book—Mrs Poujol, Mr Besnard, Mr Simonot and Mr Labourie—answers the question at length, approaching it from his or her own particular standpoint. Mr Besnard undertakes a review of the problems arising in this sector and is inevitably led to consider several definitions, including in particular one quoted from a report by J. P. Imhof, which reads as follows: 'Promotion work denotes any action taken within or brought to bear upon a group (a community or an environment) with the aim of developing each individual's ability to communicate with others and structuring social life by using semi-directive methods; it is a way of promoting integration and participation.'

In addition to definitions, the reader will find a stimulating account of the underlying principles, fields of application, functions and models of socio-cultural promotion work, together with some observations about the agents of such action. Mrs Poujol devotes a chapter to the training of these socio-cultural promotion workers, who are playing an increasingly important and diversified role in French life. The same themes are further elaborated by the authors of the last two contributions; Mr Simonot and Mr Labourie, who offer valuable information and original points of view. The whole of this part of the book provides much food for thought and rounds off a project which, within the limits already mentioned, has competently met the need for a complete picture of adult education in present-day France.

In the same year, 1978, there appeared another work bearing on the subject discussed above, which is equally important although it takes a resolutely different line of approach. Gaston Pineau's book *Éducation ou Aliénation Permanente?* takes us straight to the heart of the matter. We are opportunely reminded that it is useless to give partial treatment to a theme which embraces the whole field of educational work, and that it is wrong to apply the term 'lifelong education' to a narrow and limited sector of adult education. Mr Pineau was trained as a philosopher, and his interests have naturally led him to explore the ideological sources of lifelong education. The uninitiated reader will not go far before he is brought up short by such passages as:

> This kind of discourse aims at integrating the whole of human time (mythical dimension) into a vast project of systematization in accordance with a rational pattern (logical dimension), and these two dimensions mingle so as to reinforce one another and rule together: the mythological element ensures the effectiveness of theoretico-practical operations, and the efficiency of the latter increases the power of the former.

But the reader should not allow himself to be discouraged. Mr Pineau's study is full of real substance and the effort to follow his arguments is rewarded with a harvest of particularly illuminating observations. At the core of his thinking there is a meditation on time. We have to admit that this is inevitable as soon as we reflect on the full significance of the first of the two words making up the expression 'lifelong education'. What should we do with our allotted time on earth? How can we use it so as to accomplish our mission as human beings and transform into realities the potential capabilities with which each one of us is endowed? By what sustained and undelegated effort can we bring into play the powers of thought, of mental and corporal expression, of communication with others and with art, which exist only in embryo in most people because they have never had the chance to exercise them? How can we to do this for ourselves and by what methods can we help others in this effort at self-conquest? The only solution is to be guided by the principle that life is a constant becoming, for this gives human time its full significance.

Only if lifelong education is approached in this spirit will it become, not a form of 'alienation', but a process of self-realization. Mr Pineau, who is a young research worker attached to the University of Montreal, tells us that he has encountered many other pilgrims along this path. From the outset he bases his approach on the ideas developed in Plato's *Republic*, referring in particular to the inexhaustible myth of the cave. G. Bachelard's *Formation de l'Esprit Scientifique* and G. Durand's *Structures Anthropologiques de l'Imaginaire* have also played a decisive role in mapping out his route. But Mr Pineau has gone further than these pioneers and has set out to establish what he calls 'mythical and political' landmarks to trace the evolution of modern thought on the subject of lifelong education. He has studied the 'discourses of promoters' produced between 1950 and 1970 and reproduces what he regards as their essential arguments. Part of his book is thus an anthology. In the 200 pages devoted to extracts from the works of other writers, the reader will find all the most important contributions to the discussion on the subject which have been made during the last twenty years. The author discerns three trends: an international trend, which is especially influential inasmuch as Unesco has taken a firm stand in favour of this innovative concept; an American trend and a European trend. The three converge to highlight the need to think out an entirely new approach to educational work.

The views of critics of the concept of lifelong education are also represented. Taken as a whole, Mr Pineau's inquiry has made a first-class contribution to the study of the theoretical aspect of adult education. Now that steps are being taken in different parts of the world to set up institutional and methodological structures influenced more or less directly by the idea of lifelong education, it is to be hoped that the effort to gain a deeper insight into the fundamental reasons for the development of this concept will be pursued by undertaking the wide-ranging and rigorous research it demands, on the lines indicated by Mr Pineau.

PAUL LENGRAND

Barbara B. Burn (ed.), *Admission to Medical Education in Ten Countries*, International Council for Educational Development (distributed by Interbook Inc., New York), 1978, 160 p.

Industrialized countries have witnessed an increasingly rapid development in education and health services. Since the Second World War the main feature in the former area was a broader access to primary and secondary education; in the latter there was a call for geographical and social redistribution of health-care resources and for change in the quality of care. Admission to medical education has become one of the most salient political and social issues between the pivots of access to higher education (and to a position of high social status) and health manpower demand. The elaboration of a conceptional working model, at least for a more systematic approval for this highly complex problem is certainly needed, but this has hardly ever been attempted. It is with the hope of finding such a systematic approach that one begins to read this monograph which is the result of a multinational and multidisciplinary study on this topic. What is presented, however, is a collection of reports describing ten national systems of admissions to medical schools (Australia, Canada, Denmark, France, Federal Republic of Germany, Italy, Netherlands, Sweden, United Kingdom, United States), introduced by an editorial overview. Nevertheless, such multinational reports, as an earlier one,[1] are of considerable interest to those responsible for educational and health services planning and development. The following review will focus on a few selected dimensions of the problem and its solutions as reflected in the reports.

In all countries concerned, admission to medical education is to be seen in the context of overall social opportunity. Everywhere access to secondary education has been facilitated and broadened to a greater extent than access to higher and especially to medical education, contributing to the present impasse, perhaps with the exception of Italy. In this country, the doors to all phases of the educational system have been kept 'open', mainly for political reasons and against the obvious limitations imposed by the requirements of a functioning health services system. It is truly tragic to observe how those who failed to enter medical school in other countries overflood this already harassed educational structure. One wonders what political agreements could have induced such strange international migration. Sweden, at the other end of the scale, has carefully integrated access to medical education into a sophisticated system which distributes educational chances among the broadest possible segment of the population. Other countries lie somewhere between these two extremes, some of them use multiple criteria in addition to the traditional criterion of scholastic achievement, for access to the most prestigious of the academic professions.

The 'uncomfortably high' scholastic requirements for entry into medical education have been recognized as exerting an important influence on the pre-university educational system. They have a tendency to turn premedical education into 'battlefields'. Extensive experience about this phenomenon in the United States during more than two decades seems not to have prevented similar developments in the Federal Republic of Germany and elsewhere.

This traditional emphasis on scholastic excellence—generally leading to academic excellence—in selecting future physicians has been challenged increasingly from another angle. High physician competence does not seem to be very much related to such excellence. This has become increasingly evident since well-documented needs in primary health care appear to play a more important role in health services planning than needs for advanced technology and biomedical research. Manual, perceptive and interpersonal skills as well as positive attitudes towards health needs of individuals and the community over and above factual knowledge are recognized as important components of a doctor's quality and as preconditions of an optimal outcome of his services. Should not such qualities play an important role at the point of selection of the future members of the profession?

These concerns raise serious questions about many aspects of the educational systems including their pre- and post-university phase. However, emphasis in this monograph was put on the procedures by which transition from secondary to medical education is accomplished. These procedures are primarily determined by constitutional, legal, organizational and financial considerations. The solutions to the problem are either more of a technological or more of a conceptual nature. The former tends to stress the question of numbers at the expense of using a quality criterion. The formal consideration of a constitutional right to access to higher education in the Federal Republic of Germany led to a strange combination of admission of top scholastic performers and socially privileged 'parking students' put on a waiting list for up to six and more years! It is possible that the latter group might qualify better for the field of primary medical care than the former, which seems to be more oriented towards specialization and biomedical research. In France, similar constitutional conditions have resulted in a postponement of selection to the end of the first year of medical studies which largely offers science courses, leading to uncontrollable overcrowding in this phase. Central distributing agencies were developed in the Federal Republic of Germany, the United Kingdom and the United States.

In most countries a system of accepting students by quotas according to 'non-academic' criteria such as age, sex and previous professional experience should lead to the heterogeneity in attitude, knowledge and skills which might be most promising. An impressively diversified system of selection, based on educational and professional objectives, has been introduced at the McMaster Medical School, in Hamilton, Canada. Here, a considerable amount of thought, developmental work, training and even research appears to have contributed to overcome the highly unsatisfactory results of selecting medical students by the easy approach, namely school grades, and administrative or technological measures.

With the exception of this last model and the broad social experiment designed in Sweden, policy of admission to medical schools seems to remain a sad and haphazard enterprise. Research in this field which is based on a useful conceptual model is almost entirely lacking. Studies like the one reviewed here should be based on existing knowledge and understanding of the structure and functions of health services, the roles and requirements of doctors and their socialization into a profession which today is being much criticized, for valid and other reasons.

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Note

1. *The Selection of Students for Medical Education. Report on a Working Group, Bern, 21–25 June 1971.* Copenhagen, WHO Regional Office for Europe, 1973.

ADDENDUM

Prospects, Vol. IX, No. 2, 1979.
On page 145, the biographical note on the author did not appear. Bernard Dumont (France) is Head of the development and structure of continuing education in the French Ministry of Education. Former Chief Technical Adviser of a Unesco-assisted project on functional literacy in Mali.

Economic Aspects of Special Education

Czechoslovakia, New Zealand, United States of America

(Special education)

It is estimated that about 10 per cent of any population is handicapped, and yet this group is often overlooked by educational planners—sometimes because of a lack of know-how as regards special facilities, sometimes because of economic considerations. This publication describes how three countries—Czechoslovakia, New Zealand and the United States of America—deal with the economic aspects of special education. The studies examine not only the costs involved in providing special education for the handicapped but especially the benefits to be derived from it. The conclusion that emerges is that care and training of the handicapped is not only a moral obligation but can, in the long run, offer incontestable advantages to society.

This work will be of value to policy-makers, educational planners and school administrators, psychologists, social workers, as well as the families of handicapped young people.

Unesco 1978 152 p. 24 French francs

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The book will be of interest to all who are concerned with the problems of handicapped children, including teachers, psychologists and parents.

Professor Wall's earlier studies in this series were *Constructive Education for children* (1975) and *Constructive Education for Adolescents* (1977).

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